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HANDBOOK
FOR
RANGERS AND WOODSMEN

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RANGERS AND WOODSMEN

BY

JAY L. B. TAYLOR

FORMERLY FOREST RANGER
UNITED STATES FOREST SERVICE

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PREFACE

(1) *Object.*—The object of this volume is to serve as a guide for inexperienced men in woods work. While in its preparation, the author had primarily in mind the problems which confront a forest ranger, in Government, State, or private employ, and especially rangers on National Forests, yet the suggestions offered may be of use to others whose work or recreation takes them into rough and unsettled regions. The book is not intended and should not be considered in any way as an official or even a semi-official publication the use of which is obligatory upon National Forest Rangers. It has been prepared, however, by permission of the Secretary of Agriculture, whose criticisms have been carefully considered and at whose request certain revisions have been made, and is strictly in the nature of a private publication prepared after eight years of experience in field work of the United States Forest Service.

It is not placed before the public with any intention or desire on the part of the author to insist that opinions of inexperienced persons must coincide with the ones expressed here before satisfactory results may be obtained. On the contrary, the absolute necessity for exercising ingenuity and originality of thought, in so far as this is practicable, is thoroughly appreciated and is suggested as the most effective means of extrication from all difficulties encountered, especially those the solution of which cannot be touched upon here.

(2) *Brevity.*—Recognition of the fact that volume after volume might still fail to cover in detail any one of the subjects discussed here makes it at once apparent that only the most essential points can be covered in a book of this size. Consequently only such problems as have been found to be especially difficult for the inexperienced woodsman are considered.

(3) *Technical Terms.*—These have been avoided so far as such a course seemed practical, and all unusual trade or professional terms with which the beginner can not be expected to be familiar have been defined in the Glossary.

(4) *Cost Data.*—It is assumed as general knowledge that costs increase as western sections are reached and that tabu-

lated lists of costs covering each article and applicable to each section would require work and research of a nature not justified by or compatible with the nature of this book. Therefore the costs given range from the minimum for the cheaper grades to the maximum for the better grades of articles mentioned.

Finally, it is sincerely hoped that beginners will not be content to accept the following suggestions as the only possible or the most effective solutions of the problems involved, but that they will be continually on the alert to discover other and more effective solutions which they may transmit to their successors.

Sincerest thanks are extended to the Secretary of Agriculture, Chief Forester Graves, District Forester Ringland, and Forest Supervisors Kiefer and Hinderer for assistance rendered; to Forest Ranger Russell, who spent some fourteen years as a soldier and Forest Officer in the Philippine Islands and who contributed the article on "Field Work in the Philippine Islands"; to Forest Ranger Perry, Special Detail on Telephone Construction, Carson National Forest, for valuable suggestions offered on the subject of "Telephone Construction"; to Assistant Forest Ranger Warner, Prescott National Forest, for the timely suggestions he has offered on the subject of "Identification of Live Stock"; to ex-Forest Guard Highfill, Arkansas National Forest, for practical assistance extended in compiling the article on "Care of Horses"; to R. C. Bryant, Professor of Lumbering, and S. J. Record, both of the Yale Forest School, for their continued assistance and interest in this work; to the Moline Plow Company for illustrations and assistance furnished on the subject of "Wagons"; to the Lufkin Rule Company for illustrations and for the Doyle log rule and the table showing comparisons of various log rules; to the Pratt Food Company for advice concerning "Diseases of Live Stock"; to the Western Electric Company for their assistance and continued interest in the subject of "Telephone Construction"; to the Du Pont Powder Company for illustrations and data on "Blasting"; to the Simmons Hardware Company for illustrations and information supplied; to the International Harvester Company for information contributed; to Swift & Company and Armour & Company for courtesies extended; to the late N. H. C. Taylor, formerly of the Signal Corps, United States Army, for data supplied; to O. St. John, M. D., for assistance rendered in the compilation of the subject "Ailments"; to H. T. Southworth,

M. D., City Health Officer of Prescott, Arizona, for valuable suggestions concerning the subject of "Poisoning"; to the Southwestern Portland Cement Company for advice on the subject of "Concrete Work"; to C. C. Queen, practical blacksmith and shoer, for assistance rendered in the compilation of the subject relating to horseshoeing; to E. G. Bosserman, practical painter and paper-hanger for advice on the subject of "Painting"; to J. A. Richards, sawmill operator, for advice on the subject of "Woods Work"; to N. H. Getchell, mine operator, for suggestions concerning "Blasting"; to J. E. Bacon, packer, for assistance in the work of compiling the article on "Packing"; and to Chas. B. Weil, whose practical suggestions, offered from the view-point of an experienced camper, have proven of inestimable value in the work of assembling and preparing the subjects covered here.

J. L. B. T.

Groom Creek, Arizona,
December 1, 1916.

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Handbook for Rangers and Woodsmen

EQUIPMENT

PERSONAL

CLOTHING

ALTITUDE, latitude, and season must of course be carefully considered before field clothing is purchased, and if personal experience has taught the purchaser that garments of different weight or texture than those hereafter described will prove more comfortable in his individual case he should by all means secure them. In case of doubt he will find the following suggestions of more or less assistance until such time as actual field experience will have shown him just what articles are best suited to his personal tastes.

Official efforts have been and are still being made to popularize the use of Forest Service uniforms, the wearing of which may possibly become general, if not compulsory, within the near future. The two principal varieties of proposed uniform goods are a whipcord of serge and a cloth closely approximating this in nature and being especially strong and durable. Officers who favor the use of uniforms base their opinion on the necessity for two things, viz., the neatness of appearance of the officer as compared with his appearance in ordinary civilian clothing, and the beneficial educational effect on the general public, and upon transients in particular.

The following suggestions, therefore, are applicable chiefly to campers in general, and if followed by Forest officers should be so modified, so far as purchases are concerned, as to meet with official approval upon the particular Forests to which such officers are to be assigned.

Hat.—A hat for general field wear should be of the best grade obtainable, since the cheaper grades soon lose their shape, become limp and uncomfortable, and are eventually more costly than

the better grades. A $5.00, thirty-ounce hat will give the best all-round service. The crown should be 4½ or 5 inches high (a low crown is uncomfortably warm in summer) and the brim should be flexible and 3 or 3¼ inches wide. A stiff brim is to be avoided, especially where the hat is to be worn in thick underbrush or during very windy weather. In color a nutria tan is preferable. A black hat is uncomfortably warm in summer, and when wet invariably stains the wearer's forehead and face. Much less difficulty will be experienced in keeping the hat on in brush or during windy weather if the leather sweat-band is removed.

To Use a Hat as a Drinking-Cup.—The brim is folded upward against the sides of the crown and held there with one hand across the crown.

The end of the brim nearest the thumb and forefinger is then dipped into the water and the other end submerged later, allowing the brim to fill. The water is taken from the end most convenient, usually the one first dipped into the water.

If it becomes necessary to water a horse from a pool or stream to which the animal is unable to gain access a hat may be used in lieu of a bucket. In such a case the animal takes the water from the inverted crown.

Cap.—The most serviceable cap is leather-covered, wool-lined, fitted with ear tabs and forehead and neck protector, and costs from $1.25 to $10.00, according to style and finish. Its use is not recommended, however, unless the weather is so extremely cold that comfort can not be secured by wearing a hat.

Coat.—A coat will be found of little or no practical value except for use in lounging about camp. The heavy ready-made work-coats are not constructed in a way that allows a field man as much freedom of motion as his work requires, and if one is to be used it should be at least two sizes larger than that usually worn. A common "denim" jumper will give much better satisfaction and wear better than a coat. It is made with from two to five pockets, is short-bodied, buttons close up under the chin, and is almost indestructible. The cost varies from 80 cents to $1.50.

Coat Sweater.—This is not recommended for use in brushy country. However, if one is to be worn it should be of the best grade, made with two pockets, a roll collar, and to button to the top. The cost is about $5.00.

Slicker.—A cheap slicker is to be avoided. The best grade weighs but little more and will give much greater satisfaction. For general field use the yellow pommel slicker, made with adjustable wristlets, re-enforced shoulders, throat latch, and one outside pocket, and weighing about six and one-half pounds, is recommended. The cost varies from $2.50 to $3.50.

Shirt.—A shirt for both summer and winter wear should be of the regular medium weight, army woolen variety, with double back, two pockets, and wide collar. It will cost from $2.50 to $5.00.

Trousers.—Common "denim" overalls are recommended for general rough field work. They should be well riveted, bibless, with top front pockets, watch pocket, and two hip pickets. They cost from sixty cents to $1.50 per pair.

Corduroy is extremely heavy and stiff when wet, and except in the very best grades the nap soon wears off and breaks appear at wrinkles. The cloth is easily torn and is otherwise unsatisfactory as trousers material. A good grade of whipcord will give much better satisfaction than corduroy.

Underwear.—Medium weight, full length, woolen underwear for both summer and winter wear will be found generally more comfortable than other varieties. Cotton wear is cold and clammy when wet, and if the wearer stops exercising when warm he is quite liable to take cold. Woolen wear does not possess this disadvantage. The wearer may even plunge into water, and if he wrings his underwear thoroughly upon emerging may replace it and feel no ill effects later. Fleece-lined wear is not recommended. Suits vary in price from $1.50 to $5.00.

FOOTWEAR

Here again personal experience must dictate what purchases should be made, and the following remarks on the subject of footwear are offered only as a general guide for the field man who has never before encountered the question of comfortable footwear in outdoor work.

Work Shoes.—If considerable walking is to be done, such as in surveying or timber cruising, shoes should have wide, roomy toes and low, flat heels. They should be made to lace rather than to buckle or button. Low-cut styles allow snags and brush to injure the ankles and insteps; moreover, the entrance of leaves,

twigs, gravel, etc., soon requires their removal. A pair of forty- or fifty-ounce elkskin, full-vamped, heavy-soled, screw-fastened, seamless shoes, costing from $2.50 to $5.00 will give general satisfaction. They may be ordered with or without hob-nails.

Shoe Strings.—Cloth shoe strings should not be included in the camp equipment; they are too easily frayed, worn through, or broken to prove satisfactory. The best material from which shoe strings can be made is buckskin, whang leather, or lace leather, such strings costing from five to fifteen cents per pair. Eelskin also makes very strong, durable strings.

Hob-Nails.—These are short heavy nails fitted with large heads and designed for the protection of shoe soles and heels. Common hob-nails have large round, smooth heads, Bulgarian nails have extra large serrated heads, and Swiss and English edging nails have large pyramidal heads fitted with lips which extend upward outside of and act as protection to the sole edges. Lengths vary from ¼ inch to 1¼ inches. The points are not symmetrically fashioned like those of common wire nails, but are cut long at one side in order to lead the shank of the nail in any desired direction. Therefore, in driving hob-nails near the edge of the sole, this long side of the point is set toward the center of the sole, and thus prevents the point from emerging outside of the upper leather. Nails long enough to reach completely through the sole should not be used. They are excellent conductors and will prove very uncomfortable in extreme weather.

Soles should be nailed only along the edges with possibly one or two rows of nails through the center. Too many nails are detrimental rather than beneficial, this being due to the fact that a sole driven full of nails burns, breaks, or weakens sooner than one carrying only a few nails. Moreover, the wearer's progress is retarded rather than assisted if large numbers of nails are used, the reason for this being that so many nail-heads set close together present an almost even iron surface to the ground, and thus cause slipping.

Shoe Calks.—These are screws fitted with sharp heads and are used to prevent slipping when the shoe shank is set against a log. They are inserted in the shank by means of a short wrench which works against the squared shoulders. The points soon become dull and blunt when used in rocky country, and for this reason calks are not recommended for field use.

Heel Plates.—These are flat iron plates shaped like horse-

shoes and punched for attachment to the shoe heels. Their use is much more likely to cause slipping on flat stones or logs than if they are not used. A row of hob-nails driven along the outer edge of the heel is much more effective than a heel plate.

Bootees.—Many field men prefer these to shoes for general outdoor use and contend that the extra weight involved is more than offset by the increased protection afforded the ankles and shins. However, bootees should not exceed 15 inches in height nor sixty ounces in weight. The 15-inch, bellows-tongue, full-vamp, screw-fastened, double-sole, toe-capped variety, costing from $5.00 to $7.00, will give general satisfaction. Side gussets at the top or ankle hang in brush and weeds, and impede progress in traveling. Moccasin bootees, not having toe caps, allow stumps, logs, and stones to bruise the wearer's toes. Eyelets are preferable to hooks. The latter hang in brush, the laces are torn out, and the wearer must be continually relacing them. Eyelets require a little more time in lacing and unlacing, but during a day's tramp the extra time involved is more than compensated by the avoidance of constantly relacing hooks. Side buckles at the top are not only unnecessary, but they also present an added means of annoyance in thick brush. Outside counters soon rip loose.

Riding Boots.—The boots known as "stockmen's riding boots" should not be worn if much walking is to be done. The heels are too high and the toes are too narrow to prove comfortable in such work, and their use in general field work is not recommended. Another style of boot, however, having low flat heels and wider toes, is a general favorite among officers whose work involves both riding and walking. If these are worn it is suggested that they be made to order and a good fit secured. The cost should not exceed $10.00.

The regulation stockman's boot, used so extensively in the West, usually has a fancy stitched 17-inch top, stitched sole, 1½- or 2-inch heel, and a pair weighs from sixty to eighty ounces. The cost per pair varies from $4.00 to as high as $30.00 or $40.00, according to style and finish.

Other officers prefer ordinary shoes and spiral cloth leggings. Contrary to a general belief, these leggings are not uncomfortably warm. They originated among the natives of East India and were subsequently adopted by the British Army. Incidentally, where walking must be done, they prove excellent protection

against snake bites, experiments having shown that the poison of a rattlesnake will not penetrate two thicknesses of ordinary blotting paper. The cost per pair should not exceed $1.50.

Moccasins.—Except in the north woods of Maine, Wisconsin, and Minnesota, or in other localities where conditions render them a suitable form of footwear, these should be supplied only for camp use. They are too soft and offer too little protection to the feet to prove comfortable in general field use, and they are especially uncomfortable when used in riding. They may be low cut, ankle high or even higher, but for camp use the low-cut variety is recommended. The tan-colored, twenty-ounce, single-tie style costs from seventy-five cents to $3.00 per pair.

Rubber Boots.—In order to be water-proof these must necessarily be air-proof, and for that reason cannot be recommended for field use. If he must work in water the field man will find common leather shoes preferable to rubber boots, this being especially true of such work in warm weather.

The best style for occasional wear about camp has rubberized duck vamps, rolled sole, weighs about sixty-four ounces per pair, and costs from $3.00 to $6.00. Hip- or thigh-boots weigh but little more and cost from $4.75 to $7.50 per pair.

Storm Rubbers.—Ordinarily the field man has neither room in his pack nor use in his work for storm rubbers. They are only useless burdens and should not be included in the list of footwear.

Socks.—Medium-weight woolen socks are recommended for both summer and winter wear, and for the same reasons that woolen underwear is recommended. It not infrequently happens, however, that such footwear proves especially unsatisfactory in individual cases, and in such event the field man should of course procure whatever style of socks he has found most satisfactory. Woolen socks vary in price from twenty-five cents to $1.00.

Hose Supporters.—Supporters which encircle the leg at or near the calf should be avoided if continued walking is to be done. Their chief disadvantage lies in the fact that they must be drawn so close about the leg that circulation is impeded when it should be especially free and regular. The small two-ended clip, costing ten cents, is recommended for general use. If these cannot be secured the socks may be pinned to the drawer legs.

HANDKERCHIEFS

Nothing in this line is better for field use than a common five- or ten-cent bandana. Red will be found preferable to blue, as the latter fades when wet, the stain being removed from the user's skin only with difficulty.

BEDDING

Quilts, comforters, sheets, and pillows are unnecessary articles of bedding for field use. The first two are bulky and heavy, are no warmer than blankets and dry very slowly when wet; furthermore they seem to attract moisture and always feel clammy and damp. Sheets soon become grimy, are easily torn, and do not add materially to the comfort of a camp bed. A coat, sweater, or other clothing may be rolled up and used for a pillow.

A very comfortable, durable, and easily packed bed may be had by the use of one four-pound and two six-pound double woolen blankets 72 by 84 inches in size. These cost from $4.00 to $6.00 and $6.50 to $9.00, respectively. If it is felt that such bedding is too expensive for camp use horse blankets may be used as a substitute and will prove very comfortable. A five-pound blanket 76 by 80 inches in size costs about $2.00; one 84 by 90 inches, weighing eight pounds, costs about $3.00; and a ten-pound blanket 90 by 96 inches costs about $3.50. One of each should be secured, dark colors being preferred.

TARPAULINS

A tarpaulin is used as protection to bedding when the latter is rolled into a pack or made down on the ground. The best size is 11 by 15 feet, or the same size as a regulation wagon "sheet" or "cover." It should be of not less than eight-ounce duck, would weigh approximately ten pounds and would cost about $4.00. Ten-ounce material, same size, costs about $5.25, and twelve-ounce about $6.50. No water-proof blanket need be included in the bedding if a good grade of tarpaulin is used. A 30-foot ½-inch manila rope is long enough to tie the bed for packing and costs from thirty to fifty cents.

DUFFLE BAGS

Trunks, suit cases, grips, or satchels should never be taken on extended camping trips; the rough usage incident to packing or to other forms of transportation will soon destroy them and call

for the purchase of new articles. Aside from this fact they are very inconvenient to handle, especially if packing is to be the means of transportation.

Extra clothing and other personal equipment can best be carried in a heavy canvas bag known as a "duffle" bag, which can be purchased from any firm handling sporting goods. Such a bag is fitted with a canvas loop or handle at one end and with another at the side; the top has an inside hood supposed to be water-proof, and the bag is fastened shut with a drawstring or bar lock passed through the eyelets at the open end. As a matter of fact, however, these bags are usually constructed in such a manner that they are too long and narrow to prove satisfactory either in packing or unpacking them.

One which has been used in the field for more than six years, and which has withstood the roughest usage and given complete satisfaction in every respect, was made to order for $3.50. It is of extra heavy canvas, 34 inches deep, 22 inches wide, and has an extra heavy leather bottom riveted through the canvas into a heavy leather inside collar. The top is fitted with a pliant 2-inch leather band bearing sixteen ¾-inch eyelets. A 3/16-inch forged D-ring is attached to a leather re-enforcement on one side of the bag 6 inches below the top, and a second similar ring is likewise attached to the leather bottom.

A 2-inch leather strap, fitted with a heavy harness snap at either end, is attached to the two rings and has proven very convenient in carrying the bag or attaching it to a pack-saddle. Except at the open end, which has no inside hood, the bag is absolutely water-proof, although it has been run over by wagons, kicked about by fractious pack-animals, and otherwise been given the most severe treatment. It is fastened shut by means of a buckskin thong passing through the eyelets.

In filling, or packing, duffle bags, care must be taken not to place hard or sharp articles immediately against the canvas sides, or the canvas will be cut or worn through.

Small articles may be confined in smaller canvas bags and the latter finally packed in the big bag. One of the small bags may hold pins, needles, thread, thimble, and similar articles; another may be used for packing tobacco, pipes, matches, or match cases; and a small medicine kit may be carried in still another. These small bags should be fitted with leather drawstrings and kept closed when packed in the duffle bag.

CANTINAS

These are leather bags supplied to field men who are to do considerable riding. They are made in pairs and are designed to be carried at the saddle horn or fork. Each large bag is fitted with a smaller outer bag 5 inches wide, 8 inches long, and 1 inch deep. The large bags are 8½ inches wide, 11 inches long, and 3¼ inches deep, made bellows fashion and equipped with 10-inch flaps which cover both the large and small bag and which are made to buckle down. At the upper edge of the flap a ¾-inch strap 14 inches long buckles across into the flap of the other bag of a pair and serves as a handle by which the bags may be carried when they are to be used otherwise than on horseback. Two 6-inch straps, set 1½ inches apart, also connect the two bags and hold them to the saddle horn.

EQUIPMENT FOR A FIELD TRIP

Clothing.—The greatest problem involved in providing clothing for a field trip is not so much what to include but what to exclude from the baggage. The inexperienced person invariably burdens himself with a large amount of excess baggage which he finds later is of no use to him. Meanwhile, he suffers more or less inconvenience in transporting it about from place to place.

It is of course utterly impractical to compile a list of clothing and then declare that such articles are sufficient and that no others are necessary for any field trip and regardless of all conditions.

It is possible, however, to compile a list suitable for given conditions and to use such a list as a basis for determining approximately what equipment may be needed to meet other conditions and it is with this idea in view that the following lists are supplied. It is assumed that the work to be done is timber cruising, that the country to be covered varies in altitude from one thousand to six or seven thousand feet and lies approximately in latitude 40° north and that the work is to be done during the period from May to August. Normal climatic conditions incident to such work would justify the field man in providing himself with about the following clothing:

Underwear.—Four suits, medium weight, woolen, full length, to be changed often.

Shirts.—Four, medium weight, woolen, good grade.

Trousers.—Three pairs of denim overalls.

Socks.—Twelve pairs, medium weight, woolen, to be changed often and kept in good repair.

Shoes.—Two pairs, low, flat heels, roomy toes, high tops, capped, hob-nailed sole and heel edges, to lace.

Hat.—Soft felt, 3- or 3¼-inch flexible brim, 4- or 5-inch crown.

Coat.—Denim jumper.

Other equipment that may be included with the above is:

Handkerchiefs.—Three bandanas, preferably red.

Shoe Laces.—Two extra pairs, buckskin or lace leather.

Shoes.—One pair, low cut, soft, for camp wear.

Housewife.—Carrying pins, needles, thread, small scissors, bachelor buttons, yarn for darning.

Stationery.—Stamped envelopes and paper for all personal correspondence. Official correspondence is on official stationery and is covered under frank. Paper and envelopes are supplied.

The toilet set should include:

Shaving Outfit.
Pocket Comb.
Pocket Mirror.
Six Bars Toilet Soap.
Two Towels.
Tooth Brush and Dentifrice.
One Extra Pocket Knife.

It may seem that the foregoing lists are rather limited, but under present-day conditions the field man is seldom stationed so far from country stores or post-offices that he is unable to purchase or order any extra supplies he may need.

For a list of camp bedding, see page 7. Cots are not recommended for winter use. They permit such free circulation of air beneath the bed that practically twice as much bedding is required to assure comfort.

Camp supplies are listed on page 30, and cooking utensils on page 28.

RIDING

The following remarks on the subject of riding equipment are not offered as suggestions to experienced horsemen; their sole aim is to furnish inexperienced field men with a general idea of what equipment they may depend upon for practical results until their own experience will enable them to select equipment more in accord with their individual tastes.

Bridle.—This should be light but strong, and fancy conchas,

heavy rosettes and heavy nose pieces and superfluous straps and buckles should be avoided. Such impedimenta are uncomfortable in extreme weather, and, contrary to a general idea among a certain class of horsemen, do not add to the real value of nor contribute favorably to the appearance of a bridle. The bridle may or may not be fitted with a brow band and throat latch, although these pieces are recommended for use on animals that have developed the habit of "rubbing the bridle," *i.e.*, removing it by rubbing against a tree, post, or similar object. One form

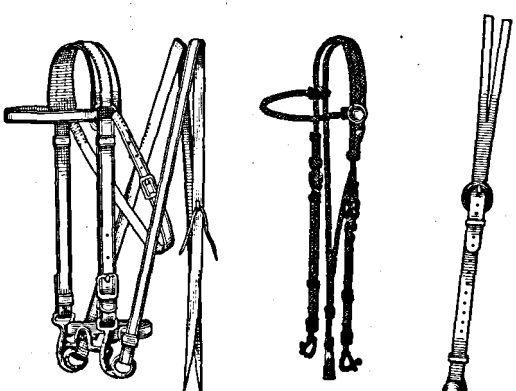


FIG. 1.—Bridles.

of bridle is fitted with ear holes instead of a brow band, but in most cases does not prove as comfortable or effective as one with a brow band.

The bridle shown at the left of Fig. 1 has ⅞-inch double cheeks, ⅝-inch throat latch, brow band and curb strap, wide layer crown piece, bar buckles, sewn-in rings, and ⅞-inch reins 6 feet long. It weighs approximately thirty-six ounces and can be bought for $2.00 or $2.50.

The one shown at the center of the same figure is made of clarified rawhide, plaited in four strands, and has no buckles or rings, the cheek pieces being regulated by adjustment of the side loops. It weighs ten ounces and costs from $1.50 to $2.00, without the reins or bit. It is so subject to stretching when wet and shrinking as it dries that it will not give satisfaction.

A side view of an ear bridle is shown at the right in the same

figure. It has ⅞-inch cheeks and 1-inch split crown, weighs about ten ounces, and costs $1.00 without the reins or bit.

Horsehair reins and headstalls are not recommended because the loose hair ends of the former are uncomfortably rough to the rider's bare hands and of the latter irritate an animal's skin.

Bit.—The best all-round riding bit, and one that can safely be recommended for general field work, is the regulation military

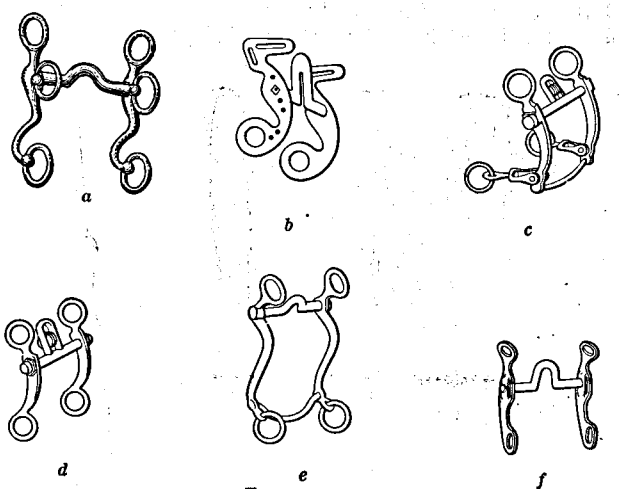


FIG. 2.—Bits.

curb bit shown at *a* in Fig. 2. It weighs sixteen ounces and costs from $1.75 to $2.00. Other styles of bit are the blued Mexican curb, shown at *b* in the same figure, weighing eleven ounces and costing from fifteen to twenty-five cents; the swivel ring-bar bit, shown at *c*, weighing seventeen ounces and costing $1.00; the low port bit, shown at *d*, bearing a roller, weighing fourteen ounces and costing seventy-five cents; and the Kentucky bar braced racking bit, shown at *e*, weighing thirteen ounces and costing fifty cents. It is especially constructed for very light work. The wrought port mule bit, shown at *f*, is designed for extra hard usage, weighs fifteen ounces and costs from fifteen to twenty-five cents.

Silver-mounted or engraved bits are not recommended. They

are usually too heavy and expose an animal's mouth to too much heat or frost to give general satisfaction.

Hackamore.—This is merely a variety of light, strong halter used chiefly in breaking, training, or controlling saddle animals. It may also be used to advantage when injuries to an animal's mouth prohibit the use of a bit. In using it it is simply hung on an animal's head, and a rope which has been tied about the animal's neck is then passed through the bozal, indicated at *a* in Fig. 3, and upward to the rider's hand. If the animal is to be trained to turn to the left the rope may be pulled steadily, or, if a double rein is being used, the right rein is held against the neck and the left rein is pulled. In turning to the right the left rein is drawn tightly against the left side of the neck, while the right rein is pulled. In this way an animal is soon taught to "neck rein," and after the bit is used no pressure against it is required in turning the animal. The hackamore shown in Fig. 3 is of rawhide with a double-looped bozal, over plaited nose piece, flat double-plaited cheeks and brow band and adjustable crown piece. No brow band is necessary in most instances. Such a hackamore weighs approximately twelve ounces and costs from $3.50 to $5.00.

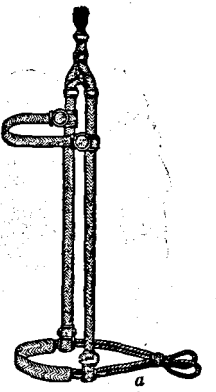


FIG. 3.—Hackamore.

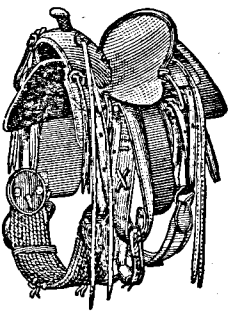
Saddle Blanket.—The most satisfactory blanket that can be obtained for steady riding is one made of three or four thicknesses of tow or "gunny" sacks carefully cleaned of all knots, bunches, and other uneven surfaces and sewn together around the edges. Such a blanket should be about 1 inch longer and wider than the under surface of the saddle skirts. When wet with perspiration or water it should be dried in the shade and care must be taken to see that burrs, twigs, etc., are not allowed to stick to either side.

Thickly padded, air-tight, bunchy, or ribbed blankets should not be used. A very thin blanket is sufficient under a properly fitting saddle, and if the saddle fits so poorly that numerous

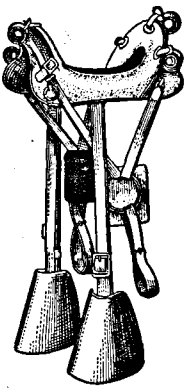
extra thicknesses of blanket are necessary it should either be discarded or rebuilt.

Saddle.—This is a question upon which few horsemen agree, and the inexperienced person who seeks advice from them may expect to receive as many different suggestions as the number of men he interviews.

However, a saddle having about the following specifications will give general satisfaction for all-round field work until the new man



Stock saddle.

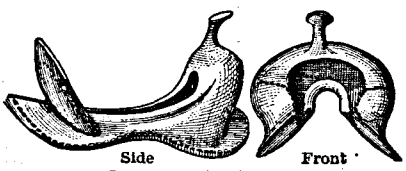


Military saddle.

FIG. 4.

learns enough about the subject to select something more to his own taste:

Tree.—15-inch, 14-inch swelled steel fork, leather-covered steel horn.



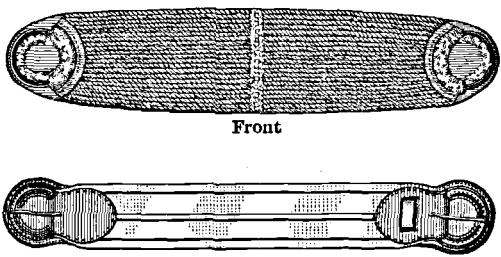
Side Front

FIG. 5.—Saddle-tree.

Seat.—In one piece with the jockeys and not too erect in the cantle.

Skirts.—Wool-lined, from 26 to 28 inches by 12 to 14 inches, round corners, laced to tree.

Rig.—Double. (This particular point furnishes more ground for contention among riders than any other single one, some declaring in favor of a double rig, some preferring a single rig,



Front

Rear

FIG. 6.—Cinches.

others advocating a three-quarters rig, and still others asserting that a five-eighths rig is best.)

Cinches.—Twenty strand Angora, front; 3½-inch belt web, rear; both fitted with leather chafes.

Latigoes.—Off side: 1¾ inches wide, 20 inches long, double

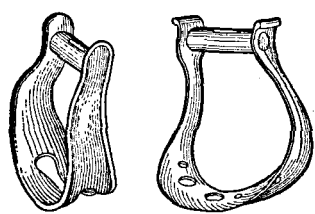


FIG. 7.—Iron stirrups.

to loop through ring of rig; near side: 1¾ inches wide, 7 feet long, punched to buckle into cinch ring or cinch buckle.

Stirrup Straps.—2¾ inches wide, to buckle.

Stirrups.—Steel, leather-covered and lined.

Fenders.—9 by 16 inches.

Tapaderas.—Short, "monkey nose," one piece.

Finish.—Plain.

Weight.—Thirty pounds.

Cost.—From $30.00 to $40.00.

Swelled forks are preferable to straight forks on account of the extra thigh grip they afford. A wide flat seat will prove

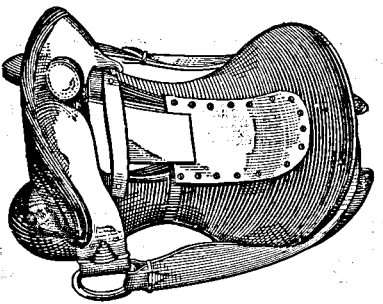


FIG. 8.—Single rig seat plate.

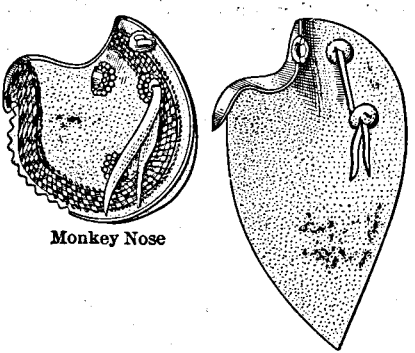


FIG. 9.—Tapaderas.

FIG. 10.—Saddle horns.

much more comfortable than a high narrow one. Steel stirrups are practically indestructible, will outlast any ordinary saddle,

and when lined with leather are not appreciably hotter or colder than wooden stirrups. Long "mule-ear" tapaderas are not only a source of useless and extra weight, but are even troublesome in thick underbrush, and, contrary to a prevalent idea, cannot be thrust forward at such times to protect a horse's forelegs. Cinch buckles facilitate fastening and unfastening the cinch and, opinions of some horsemen to the contrary notwithstanding, do not break any oftener than latigoes and cinch rings. In attaching them to the latigo the latter is run through the upper slit from the rear, back through the ring in the rig from the front, then down through the lower slit of the buckle from the rear. The loose end of the latigo is then hung up in the loop provided for it under the fork or just back of the cantle edge at the rear.

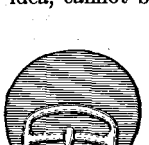


FIG. 11. — Cinch buckle with chafe attached.

Single and three-quarter rigs will not prove satisfactory for all-round work; they are designed for certain forms of horseback work and can seldom be used successfully otherwise. The rear cinch of a double rig seldom need be used, the chief advantage of such a rig being the location of the front ring.

Deeply engraved or hand-carved trimmings are to be avoided. They increase the cost of a saddle without adding to its practical value and render cleaning and oiling more difficult.

Spurs.—These are almost indispensable when western-trained horses are to be ridden, but are otherwise an unnecessary part of the riding equipment. Three general styles are shown in Fig. 12. The one indicated at *a* is best suited to general field work. The fork or counterpiece should be at least ½-inch wide, the shank should be not less than 2 inches long, and the rowel should have a diameter of at least 1½ inches. Heavy silver ornaments, such as large buttons, bells, knobs, and chains, not only fail to increase the practical value of a spur but also render it uncomfortably heavy and unnecessarily expensive. A pair of spurs similar to those described above can be purchased for $1.50 or $2.00.

Spur straps should be wide enough at the center to cover the entire instep. If laced shoes are worn narrow straps will allow the chaparejo cuffs to cut the laces, and if boots are worn the cuffs will eventually cut through the insteps.

Other spurs, very seldom used in field work, are shown in the same figure. A "heel" spur is shown at *b* and is designed

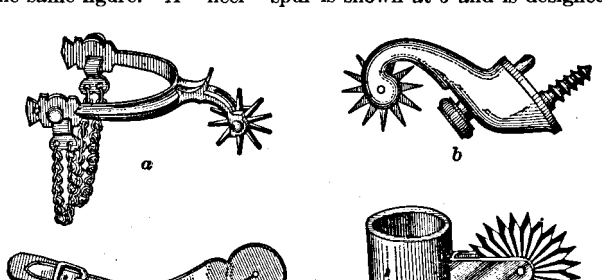


FIG. 12.—Spurs.

to be screwed into the boot heel, where it is made fast by means of a small set screw beneath the rowel.

The "whip" spur, shown at *c*, is fitted with a flat band through which the whip butt is thrust. A spur strap is shown at *d*.

Quirt.—Ordinarily the field man need not burden himself with a quirt, but if an unusually vicious animal is to be ridden and can not be well controlled with the reins and spurs a quirt may

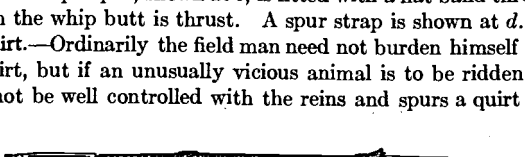


FIG. 13.—Quirts.

prove of considerable advantage. Two styles of quirt are shown in Fig. 13. The upper one is of plaited rawhide with loaded butt, weighs from twelve to sixteen ounces, and costs from sixty to seventy-five cents. The lower one is of sewn leather, shot-loaded, and costs about fifty cents.

Chaparejos.—These are commonly known as "shaps" and are indispensable in brushy country, where a rider's legs and trousers

require continual protection. Three general styles are shown in Fig. 14. For all-round work the ones shown at *a*, known as "Texas," or "bat-" or "buzzard-wings," are recommended. They are fitted with a series of rings and snaps which hold the legs shut. By reason of the fact that these shaps need not be

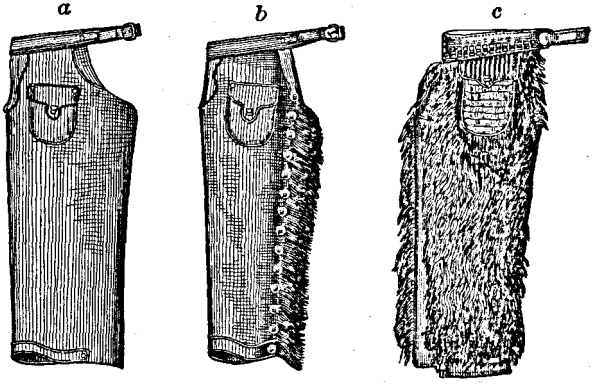


FIG. 14.—Chaparejos.

drawn on and off over the feet but may be unsnapped at the sides, they are much more convenient than the closed leg varieties. Furthermore, if spurs are worn, these need not be removed if the shaps are to be laid aside temporarily. Such shaps should be of oiled leather with side extensions not wider than 5 inches. Five rings and snaps are preferable to a larger number. The weight should not exceed five or six pounds and the cost varies from $13.00 to $15.00, plain finish.

A heavier variety of these shaps is made for use in extra brushy country and for corral work, where the rider's thighs and hips are subjected to constant pressure of the rope. The belt is extra wide and thick and the legs fasten shut from the inside with loops and leather buttons. The leather is extra heavy and stiff and the price runs from $18.00 to $25.00, plain finish.

The closed leg variety, shown at *b*, costs from $15.00 to as much as the purchaser wishes to pay for extra fancy style and finish.

The hair front variety, shown at *c*, can not be recommended for any kind of field work. They are not only heavier than the plain leather varieties, but are also very unsatisfactory in brushy country, where the hair is continually hanging and being torn out. Moreover, in stormy weather, the hair catches and holds rain, snow, or sleet and the shaps soon become too heavy for comfort. The cost runs from $15.00 to as high as the purchaser wishes to pay for finish.

PACKING

In most parts of the West, where travel facilities are usually more or less limited, supplies and equipment must often be transported from place to place by means of pack-animals, but throughout the greater part of the South and Southeast transportation is by means of wagons. It is therefore advisable for the camper or woodsman to ascertain previously whether or not he will have use for a pack outfit in the section he expects to enter.

PACK-SADDLE

Muley.—This style of pack-saddle derives its name from the construction of its forks, illustrated in Fig. 15. They are rounded off at the top, and ropes or other fastenings are passed through under the bow.

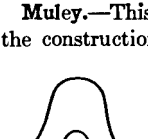


FIG. 15.—Fork of "muley" pack-saddle.

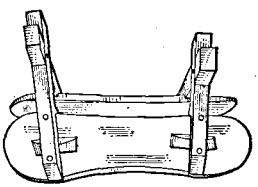
Mexican packers of the Southwest, who often construct their own pack-saddles, hew these forks from the crotches of limbs of some tough wood such as Gambel oak (*Quercus Gambelli*) or Arizona white-oak (*Q. Arizonica*). These are then nailed or bolted securely to the saddle-bars and the whole is usually, though not always, covered with rawhide.

Cross-Tree.—This saddle has forks made as shown in Fig. 16, although the rounded opening beneath the cross may not appear in some varieties. Ropes may be passed around or through such forks, and in either case will not work off unless loosened. The cross-tree saddle is recommended for field work.

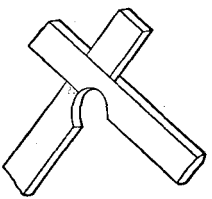
Combination.—Another form of tree seldom used in packing is a combination pack and riding tree, but this is not recommended for any field use whatever. The cross-tree affords much better facilities for fastening the pack to the saddle, weighs only about

six pounds, and can be bought for $1.50; the combination tree weighs twelve pounds and costs $3.50. For illustration of pack-saddle parts (cross-tree) see Fig. 18.

Parts.—In order to present a more definite idea of what the



Cross tree pack saddle.



Fork of cross tree pack saddle.

FIG. 16.

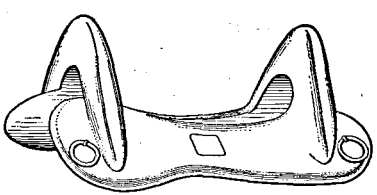


FIG. 17.—Combination pack and riding saddle-tree.

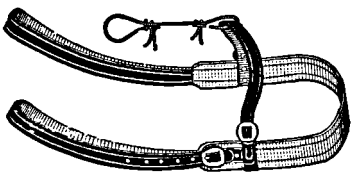
best form of pack-saddle should be, specifications of each part are given as follows:

Breeching.—This should be of ordinary 3-inch back-band web with 1⅛-inch side and hip straps. To be most effective both the latter should be lengthened till the breeching works below the points of the hips rather than close up under the root of the tail. Such breeching costs about $1.00.

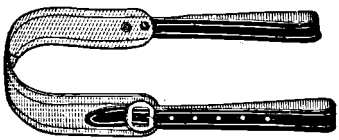
Breast Collar.—The body of the breast collar should also be of 3-inch back-band web and fitted with 1¼-inch leather side straps. If the latter are left long enough to allow the collar to fall too far below the points of the shoulders the animal will experience more or less difficulty in traveling. If allowed to work above the shoulder points it may cause the animal to choke down when steep grades are ascended. Proper regulation will allow it to work just below the points of the shoulders. If necessary a strap may be fastened from one side strap over the

animal's neck to the other. The cost of such a collar is about $1.00.

Cinches.—The best cinches for all-round work are of 4-inch



Breeching.



Breast collar.

Cinch.

FIG. 18.—Pack-saddle parts.

folded canvas fitted with a forged ring in each end. If rear cinches are to be used they should be made of the same material. The cost is about sixty-five cents.

Latigoes.—These may be known as "tie straps" and are used in connecting the cinches to the rigging. They should be not less than 3½ feet long and 1¼ inches wide, and should be made to tie rather than buckle. They cost about twenty-five cents each.

Rig.—The rigging of any saddle is that part into which the cinches are fastened by means of the latigoes. They may be either single or double in pack-saddles, the one providing for only one cinch, the other for two. They should be well looped about

the forks and securely nailed to the saddle bars. The single rig costs seventy-five cents, the double $1.25.

Full-Rigged Saddle.—A single rig, cross-tree pack-saddle, burro size, with 1⅛-inch rig, wrapped about the forks and nailed to the bars, 1¼-inch latigoes, 3-inch back-band web, breeching of the same material with 1⅛- or 1¼-inch leather

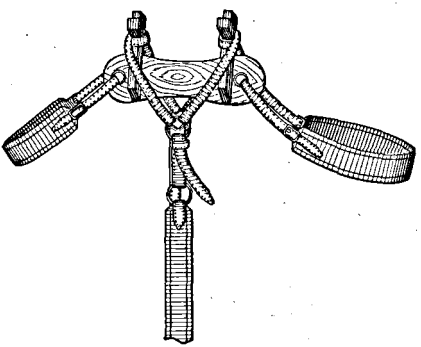


FIG. 19.—Full-rigged pack-saddle. (Single rig.)

side straps, and 4-inch folded canvas cinches, weighs approximately nine pounds and can be purchased for from $4.50 to $6.00; double-rigged it weighs ten pounds and costs about $6.00 to $7.00; horse size, double rig, costs about $8.00.

Lash Rope and Cinch.—These are used in fastening the top pack to the saddle. The cinch should be of 4-inch folded canvas fitted at one end with a forged ring and at the other with an iron lash hook. Together with 30 feet of ½-inch manila rope it can be purchased for about $1.75.

FIG. 20.—Lash hook.

Panniers.—These are heavy canvas bags equipped with leather loops to hang over the saddle forks. They are convenient receptacles in which to pack small loose articles, but are by no means absolutely essential to a pack outfit and are not recommended for general field use. The loops soon wear out or break, the canvas tears or wears through, and continual repairing soon becomes necessary. Ordinary "gunny" sacks or

heavy flour or feed sacks will serve the purpose as well, and when badly worn or damaged may be discarded without loss. Instead of being attached to the saddle by means of loops these are fastened with a grain hitch. (See Packing, p. 147.)

ANIMAL

Halters.—These should be supplied for work- and saddle-animals if the nature of the field work requires them to stand tied for extended intervals. They may be of leather or rope or may consist simply of a tie rope.

Leather.—The best halter for field use is made of 1¼-inch flat leather, fitted with squares where the cheeks support the

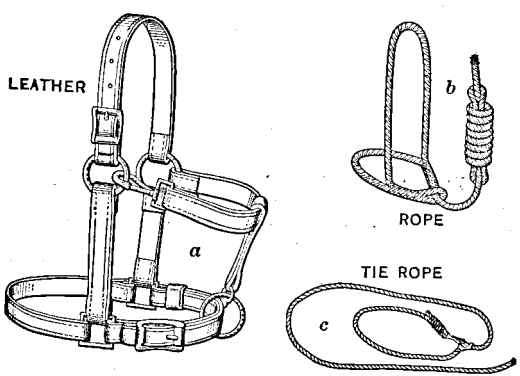


FIG. 21.—Halters.

nose piece and bozal and with rings where the crown and cheeks meet. One end of the throat latch is sewed into the off ring and the other end is fitted with a snap to hook into the near ring. The crown and bozal have buckles to permit lengthening or shortening or opening or closing the head-stall, while the cheeks and the off end of the crown piece are sewed into the rings which carry the throat latch. One end of the tie rope should be fitted with a substantial snap to hook into the chin ring, and the other end should be tightly wrapped with fine wire or heavy cord. Such a halter, together with the tie rope, costs about $1.25. See *a* in Fig. 21.

Rope.—A ready-made halter of jute, cotton, or hemp can be bought for fifty cents. The crown and cheeks are in one piece, while the nose piece, bozal, and tie rope are in another. Such a halter is light, strong, and serviceable, provided the animal to be tied is fairly gentle and well trained. Its chief disadvantage lies in the fact that it can be easily slipped if accidentally hung over a post, snag, or similar object.

If a rope halter must be made in the field, a ½-inch cotton rope 12 feet long should be used. An eye splice is made in one end of this and the other end is passed through it to form the nose piece and bozal. The cheek and crown piece should be cut long enough to reach from back of the animal's ears down either side of the head to a point about 2 inches above the mouth. Ordinarily it will be from 28 to 36 inches long after it is spliced into the other rope, one end being spliced in about 6 inches from the eye splice and the other some 6 or 8 inches farther along. The material required for such a halter costs about twenty-five cents. See *b* in Fig. 21. For splices, see p. 335.

Tie Rope.—This should be of ½-inch cotton rope, 10 feet long, and fitted with a harness snap spliced into one end, the other end being wrapped with fine wire or heavy cord or else knotted in a Turk's head. See Knots, p. 325. An iron band, bearing an eye-screw, and especially designed for the purpose, is then fitted to the rope at a point far enough from the snap to allow the snap to be hooked into the eye after the rope has been placed about the animal's neck. The rope will cost ten cents and the iron band as much more. See *c*, Fig. 21.

Hobbles.—A single hobble, sometimes known as a "picket" hobble, and a pair of double hobbles are illustrated in Fig. 22. They are for use in tying an animal's legs together, and thus prevent it from straying too far from camp. All should be of 1½-inch leather with 2-inch single strap lining and equipped with chains and swivels. A picket hobble weighs about one pound and costs $1.00 or $1.25; double hobbles weigh approximately thirty ounces and cost the same as picket hobbles.

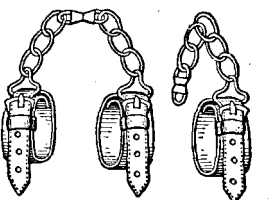


FIG. 22.

Picket Pin and Rope.—When neither halter nor hobbles are available an animal may be "picketed" out to graze. The picket pin and rope shown in Fig. 23 cost about $1.00. For general purposes the rope should be not less than 30 feet long and fitted with a strong snap at either end to facilitate fastening it into and removing it from the pin or hobble. The pin should be 15 inches long, and equipped with a swivel link at the upper end.

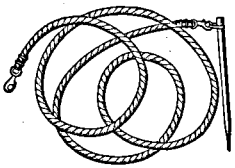


FIG. 23.—Picket pin and rope.

Feed Bags.—These are known as "morrals" in the West and Southwest, where the camp equipment is not complete without them. They are fitted with a crown piece, and after the grain is placed in them are suspended from the animal's head. It soon learns to lower its head and allow the bag to rest on the ground so that the grain may be reached.

Only the best grades should be used. These are of heavy cotton duck or canvas, are double sewed and riveted, have

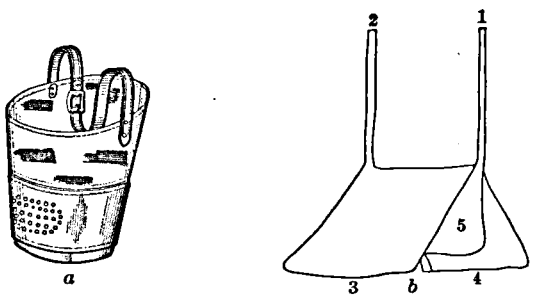


FIG. 24.—Morrals.

heavy leather bottoms, lower walls and ventilators, and the crown piece is of leather. They weigh approximately thirty ounces and cost about $1.50 each. See *a* in Fig. 24. An improvised morral made from a gunny sack is shown at *b*. This can best be made by seizing one upper corner of the sack, stand-

ing on the corresponding lower corner, thrusting a knife-blade through both sides of the sack and ripping them out to the end. The blade should be thrust through the sack at a point about 2 inches in from the edge, as the sack is flattened, and 14 inches from the bottom. The bag is shown at 5, the pieces 1 and 2 are tied together and serve as a crown piece, and the pieces 3 and 4 are tied together snugly about the animal's jaws or thrust under the cheek pieces to prevent loss of grain by spilling if the animal tosses its head in an attempt to secure the grain.

Bells.—Animals should be belled when turned out to graze at night or during times when they are not to be used. Some of them stray to a considerable distance from camp even when hobbled, and unless bells are provided more or less trouble will be had in finding them.

The best camp bells are the small ordinary cow bells generally known as "horse" bells. Size No. 5 is 3⅜ inches high and has a mouth 2¼ by 3 inches. It costs twenty cents. Black leather bell collars 2 inches wide cost about forty cents. Usually one bell to every three or four animals will prove sufficient.

Combs and Brushes.—These should always be included in the field equipment if horses are to be worked or ridden. Two styles

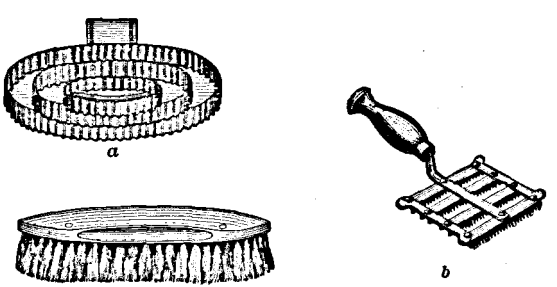


FIG. 25.—Curry-combs and brush.

of combs are shown in Fig. 25. The one shown at *a* is recommended for general field use. It is circular, of spring steel, and bears three complete circles which work independently on each other and which are attached to an iron back by a hinge joint. The handle may be of wood or leather. It is strong and com-

pact, will stand the hardest kind of treatment, and costs about twenty-five cents.

The comb shown at *b* is especially unsatisfactory for field use. The bars and teeth soon become bent, the handle takes up as much room as the comb and may soon work loose or break, and the shank may be bent, broken, or otherwise damaged in packing. The cost is ten cents. The brush shown at *c* has a heavy wooden back 3 inches wide and 8 inches long with India fiber brush 1½ inches long. It costs twenty-five cents and should be included in the field equipment even if there is no room for the comb.

COOKING

For Stations.—For permanent stations or camps, the following cooking equipment will be found very convenient. The list is rather elaborate for field work, but where the field man need not pack his kit about from place to place he will find too many utensils preferable to too few; furthermore, he may have occasion to prepare meals for visitors or for local residents who may call on business:

Article	Capacity	Approximate Cost
1 Dishpan	18 quarts	$0.50
1 Coffee-pot	4 quarts	.50
1 Tea-kettle	6 quarts	.40
1 Double boiler	1½ quarts	.40
1 Water pail	12 quarts	.40
3 Straight kettles	7 quarts	2.80
2 Pudding pans	3½ quarts	.50
2 Bake pans	4 quarts	.35
1 Cup	1 quart	.15
1 Ladle	¼ quart	.05
1 Dipper	½ quart	.05
1 Bread-raiser	8 quarts	.80
1 Colander	4 quarts	.25
1 Frying pan	.....	.35
Total		$7.50

His dinner set should include:

4 Cups and saucers	$0.50
6 Plates	.75
3 Bowls, 8-inch	.45
6 Knives and forks, iron handles	.75
6 Teaspoons	.15

Article		Approximate Cost
3 Tablespoons		$0.15
1 Soup spoon		.15
1 Sugar bowl		.40
1 Salt and pepper shaker		.35
1 Meat platter		.50
1 Vegetable dish		.60
Total		$4.75

Other utensils to be used about the kitchen should be:

1 Garbage bucket	18 quarts	$1.25
1 Wash basin	.....	.25
1 Soap dish and grate	.....	.10
3 Glass jars	2 quarts	.30
1 Bread box, 8 by 10 by 20 inches	.....	.25
1 Butcher knife	.....	.25
1 Can opener	.....	.15
Total		$2.55
Total cost of cooking outfit		$14.80

All dishes should be of granite or enamelware; the cook stove should be No. 8, four holes, iron top, and wood or coal grate, and is generally furnished upon requisition. Costs given are for enamelware.

For Temporary Camp.—Two men on a camping trip should provide themselves with the following cooking utensils:

1 Dutch oven with lid.
1 Bucket, galvanized, 18 quarts
1 Bucket, galvanized, 14 quarts.
1 Cup, 1 quart.
2 Cups, 1 pint.
4 Plates.
1 Butcher knife.
2 Table knives and forks.
2 Tablespoons.
1 Kettle, straight, 10 quarts.
1 Kettle, straight, 6 quarts.
1 Canteen, gallon.
1 Combination can and bottle opener.
1 Frying pan.

The Dutch oven is a low, flat, heavy iron kettle for use over camp fires or live coals. The average size is about 10 inches in diameter and from 2 to 3 inches deep. It is fitted with three substantial legs and a short, heavy handle. The lid is fitted with a raised edge or rim designed to hold live coals and supply heat from the top. Other vessels of the kit should be granite or enamelware; knives and forks should have iron handles and spoons should be of tin.

Such a kit weighs about twenty-five pounds and costs about $5.00. It can be most conveniently packed by dividing it into

three parts: The plates, knives, forks, and spoons are carried in the Dutch oven, the smaller bucket and the kettles and cups are carried in the large bucket, and the frying pan is carried separately.

PROVISIONS

While the following lists of provisions, compiled for one man for thirty days, must be accepted as including only approximate amounts, they will be of assistance to the new man when he must lay in a supply of such articles. It should be borne in mind also that a variety of food which appeals to one person may not suit another and that personal tastes must therefore be considered in making out a bill of supplies based on these lists:

For Stations

Baking powder	1 pound	Pickles	2 quarts
Beans	5 pounds	Potatoes	25 pounds
Butter	3 pounds	Rice	2 pounds
Canned fruit	10 quarts	Salt	2 pounds
Catsup	1 quart	Soda	8 ounces
Cereals	4 pounds	Spices	1 pound
Coffee	3 pounds	Sugar	10 pounds
Dried fruit	5 pounds	Tea	8 ounces
Eggs	3 dozen		
Flour	30 pounds	MISCELLANEOUS	
Lard	5 pounds		
Meal	2 pounds	Matches, 1 box, 1,000	
Meat, salt	8 pounds	Soap, laundry	2 bars
Milk, canned	10 quarts	Soap, toilet	2 bars
Pepper	2 ounces	Tobacco	

For Temporary Camps.—Two men expecting to be in camp for fifteen days should provide themselves with the following:

Baking powder	1 pound	Meat, salt	10 pounds
Beans	10 pounds	Milk, canned	8 quarts
Butter	2 pounds	Pepper	4 ounces
Canned fruit	8 quarts	Potatoes	20 pounds
Coffee	4 pounds	Rice	2 pounds
Dried fruit	3 pounds	Salt	2 pounds
Flour	35 pounds	Sugar	8 pounds
Lard	10 pounds		

It is also well to include ten or a dozen candles in this list. This supply of provisions, together with the cooking outfit, hobbles, picket ropes, or extra pack ropes, and bedding for two men, can be carried on one pack-animal.

CONSTRUCTION WORK

TELEPHONE LINES

General.—Telephone lines are built and maintained by the Forest Service chiefly as a means of quicker communication between different officers' headquarters or between such headquarters and lookout points. The actual work of construction and maintenance, invariably affected by local conditions, is carried on under specific instructions from the proper office and for that reason cannot be discussed in detail here. A few general rules of construction are given, however, merely as guides for inexperienced men engaged in this work.

Costs.—Local conditions affect this problem to such a degree that it is impossible to offer any definite suggestions concerning cost estimates. Such items as the nature of the ground to be worked over, local sources of supply, transportation facilities, the number of "poles in place," the ease or difficulty with which other poles may be secured and set, the amount of swamping to be done, and the best camp sites available, all affect the question of costs. Lines have been built, where no swinging insulators were used, for as low as $20.00 per mile. A general statement of costs in such cases is about as follows: [1]

No. 9 wire	$11.00
Insulators, pony, glass	1.05
Brackets	.60
Spikes	.25
Labor	7.10
Total	$20.00

Preliminary Survey.—This is made before actual construction begins. The proposed route to be followed should be marked with stakes set at points where poles are to be set, and these stakes should bear any information required by the workmen for proper setting of the poles. It may not be advisable to follow this survey in all instances, and deviations are permissible if circumstances demand them.

[1] Supplied by Forest Ranger Perry, Special Detail on Telephone Construction, Carson National Forest.

Location.—Location of telephone lines should be determined by the following factors:

(1) The shortest and most direct route practicable.

(2) Possibilities of following roads or trails in order that first cost of construction and subsequent cost of maintenance may be kept at a minimum.

(3) Best points for connection with desired points not on the main line or with points of possible future importance.

(4) Avoidance of canyons and streams exceeding 500 feet in width; also of power transmission or electric light lines. Telephone lines should not parallel high-power transmission lines nearer than ½ mile.

(5) The accessibility of detours necessary to avoid bad country or scarcity of pole material.

(6) The advantage, if any, of increased expense for material over one route as compared with increased cost of labor over another.

(7) Possibilities of future patrol of the line as affected by present or proposed bridle trails the entire length of the line.

(8) Possibility of securing rights-of-way across private lands.[1]

Equipment.—Equipment for the lineman consists of a pair of 8-inch side-cutting pliers, a pair of reversible connectors, a light ax with a 16-inch handle, a safety belt and strap, a pair of hooks or climbers, and two Buffalo grips with 24 feet of ½-inch rope. Swampers should carry 4-pound double-bitted axes, whetstones, and 8-inch files. If required to do any climbing, they should be supplied with hooks and safety belt and strap.

Transportation.—This is not a serious problem if wagons can be used, but is more difficult if pack-animals are required. No. 9 galvanized iron wire, which is the standard wire used by the Forest Service, is put up in ½-mile coils weighing one hundred and sixty pounds each. If it is to be packed all the ties except one are cut, and this one is re-enforced, the coil is opened in half, and two men can then drop it down over a pack-saddle, one-half on either side. It should be tied securely to the saddle and not allowed to work loose. Insulators and spikes may be packed in feed sacks or panniers. Brackets may be strung on

[1] Verbal permission will not suffice. The concession must be drawn up in regular form on blanks supplied for the purpose.

wires, about twenty-five to a wire, each bundle weighing approximately sixteen pounds. These may be tied to the saddle without difficulty.

Two pack-animals are required in packing poles. The regular size poles may be packed in pairs and should be fastened high up on the saddle, the animals working tandem fashion one at either end of and between the poles. Short sharp curves must be avoided, as the animals will not be able to pass around them. Extra long heavy poles must be packed separately and should be securely fastened to the tops of the saddles. Burros will be found preferable to horses for packing, since the latter usually carry their heads too high and are much more likely to become excited in case of accidents.

Right-of-Way Clearance.—Rights-of-way through timber or brush should be wide enough to provide free access of mounted patrolmen over the entire length of the line. Dead or leaning timber that may fall across the line and all branches which may touch or hang close to the wire should be removed. Rubbish and slash resulting from such removal should be carefully disposed of in order to lessen the fire danger.

POLES

Material.—The best poles obtainable are of cedar, such as red cedar (*Juniperus Virginiana*), Western red cedar (*J. occidentalis*), one-seed juniper (*J. monosperma*), rock cedar or mountain juniper (*J. sabinoides*), California juniper (*J. Californica*), and Utah juniper (*J. Utahensis*), although the last named seldom reaches a height sufficient for standard poles. Alligator or checkered bark juniper (*J. pachyphlœa*) is widely used in the Southwest for fence posts, and is also frequently used for telephone poles when it is found tall and straight enough for this purpose. However, it is too light and brittle to make durable poles.

Red Douglas fir (*Pseudotsuga taxifolia*), also known as Douglas spruce, is also quite durable and as a rule can be easily obtained throughout most parts of the Rocky Mountain regions. Fire-killed poles of sugar pine (*Pinus Lambertiana*), obtainable in nearly all parts of the Northwest, and of Rocky Mountain white pine or limber pine (*P. flexilis*), found on the eastern slope of the Rocky Mountains, are almost as durable as cedar, and generally possess the advantage of being already peeled and sea-

soned at the time they are cut. Bald cypress (*Taxodium distichum*), also known as deciduous cypress, sassafras (*Sassafras sassafras*), locust (*Robinia pseudacacia*), white oak (*Quercus alba*), post oak (*Q. minor*), chinquapin (*Q. acuminata*), and black walnut (*Juglans nigra*), all common to the South and Southeast, are likewise durable and make good poles. Redwood (*Sequoia sempervirens*), occurring near the Pacific Coast in southwestern Oregon and northwestern California, also makes durable poles.[1]

Dimensions.—The following table shows the dimensions that have proven the most satisfactory:

Length, in Feet.....	18	22[2]	25	30	35	40	45
Top Diameter, Inches.....	5	5	5.5	6	6	6.5	7

[2] Length of standard Forest Service pole.

It is not always possible to obtain poles having exactly these dimensions, but the table will serve as a general guide and should be followed as closely as possible.

FIG. 26.

Preparation.—Only the straightest timber should be selected, and if dead must be perfectly sound. Poles that are to be used in supporting extra long heavy spans of wire or which may otherwise be subjected to severe strain should be of the very best quality of material obtainable. The best time for cutting is when the sap is "down" or during the winter months, the poles being peeled as soon as cut and all large knots, splinters, and chips being hewn away. The upper ends or tops are "roofed" or beveled as shown in Fig. 26. The lower ends or butts are cut square across. After the poles have been peeled and roofed and otherwise properly shaped they are placed where they will season, and may be piled in tiers not nearer to each other than 6 inches in the same or in different tiers, the lowest tier being propped up at least 6 inches above the ground. If

[1] See following Forest Service publications:
Bul. 88. Properties and Uses of Douglas Fir, pp. 60 and 62: Bul. 95. Uses of Commercial Woods of the United States (Cedars, Cypresses, and Sequoias), pp. 15, 18, 27, 39, 46, and 49: Bul. 99. Uses of Commercial Woods of the United States (Pines), pp. 56, 72, 75, 82, 87, and 92.

they have been cut here and there, one or two in a place, they should be propped well up off the ground and left in such a position that as they season they will not twist, warp, or rot. Seasoning should cover a period of two or three months.

Preservative treatment may be applied after they are thoroughly seasoned, while they are perfectly dry, and at times when they are free of frost. See page 358, Appendix.

Poles in Place.—These are simply trees growing at convenient points for the location of poles along the line and are trimmed and topped at the proper height and left standing. When treated in this manner some varieties of timber last better than when not. Chief among the more durable ones are Douglass fir, white pine (*Pinus albicaulis*), and white oak. White fir (*Abies concolor*) and piñon (*Pinus edulis*) soon rot and do not make satisfactory poles in place. Yellow pine (*Pinus ponderosa*) usually rots within a year or eighteen months, unless the pole is very large. Aspen (*Populus tremuloides*) may sprout and stay green if topped in the spring, as will also most of the oaks. The sprouts appear at the point of topping and must be removed before they reach a size or length that will allow them to rub against the wire and impair communication. Poles in place should have a minimum top diameter of 4 inches and should have all branches removed.

Use of Different Lengths.—Standard Forest Service poles are used in all cases except:

(1) When a line crosses a railroad; the wire must be not less than 26 feet above the track.[1]

(2) When a line crosses a wagon road; the wire must be not less than 14 feet above the road.[1]

(3) When a line crosses other lines; the wire should be not less than 18 inches above the other line.

(4) When lines are run across country where brush exceeds 10 feet in height; the wire should be held at least 4 feet above the tops of the brush.

(5) When lines cross country where snow may drift higher than 10 feet; the wire should be held at least 2 feet above the tops of probable drifts.

(6) When spans exceed 500 feet in length; poles must be sufficiently high and heavy to support the extra weight.

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[1] Higher if the State laws require it.

(7) Where poles must be set at such points that extra long spans demand unusual sag; the lowest part of the wire should be held high enough to allow uninterrupted passage of travelers and stock beneath it.

Utilization.—In order to secure the greatest stability and efficiency of a line, care must be taken to distribute the poles where different lengths will do the most good. The largest and strongest ones should be used at points where the strain of the wire is greatest, such as at corners, along curves, under long spans and at terminals and switching points. Lighter and weaker poles should be set at points where they will be subjected to only moderate strain.

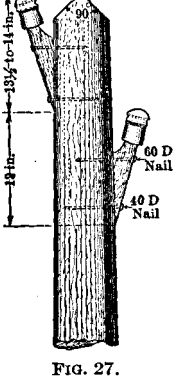


FIG. 27.

Spaces.—Under ordinary circumstances straight lines should have thirty poles to the mile, thus making the average pole space or length of span 176 feet. If the line makes a turn at right angles the spaces at either side of the turn should not exceed 100 feet in length. This same length of span is also used in spans adjoining one from 300 to 500 feet in length. It is likewise used in short, sharp curves.

Attaching Brackets and Insulators.—Brackets are attached to the poles at right angles to the ridge of the roof and before the poles are raised. A 60-D spike is used in the upper hole and a 40-D in the lower, knots, thick rough bark, and other irregularities being hewn away if the brackets are to be attached to trees. Brackets are always so attached that after the poles are set they will be on the outer side of curves, but when the poles carry two lines then the brackets are placed on exactly opposite sides of the poles. They are fitted with the insulators before the poles are raised. See Fig. 27.

Holes.—Except where conditions render it impossible or inadvisable these should have about the following depths:

Length of pole, in feet...		18	22	25	30	35	40	45
Depth of hole, in feet	Earth...	3.5	4.0	4.5	5.0	6.0	6.5	6.5
	Rock...	3.0	3.0	3.5	4.0	4.5	5.0	5.0

Holes along curves or in loose soil should be at least 6 inches deeper than shown above, and should have a diameter about 6 inches greater than that of the pole to be set. If poles must be set in solid rock, it usually proves more economical to drill 2- or 3-inch holes and use pipe for poles.

Setting.—In setting poles they are turned so the ridge of the roof will be parallel with the line wire, care having been taken to roof the crooked poles so the crooks will face the next pole in the line when the ridge of the roof is parallel with the line. All poles in straight lines are set as nearly perpendicularly as possible, but in curves are given a certain amount of rake which is about as follows:

Pull, in feet.....	5	10	15	20	25	30	(See Fig. 28)
Rake, in inches.....10		16	24	33	42	..	(See Fig. 29)

The pole must be braced or guyed if the rake exceeds 42 inches.

No attempt should be made to adhere strictly to these figures regardless of all conditions; neither should they be totally disregarded.

Tamping.—Some heavy iron instrument, such as a crowbar, having a beveled point will be found preferable for this use to one having a broad, flat-tamping surface. Fine dirt should be well

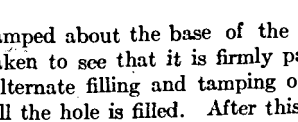


FIG. 28.

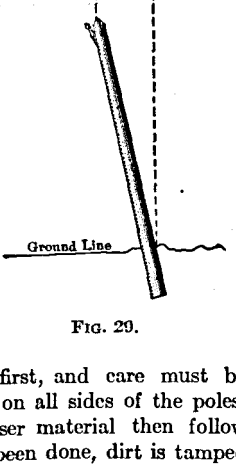


FIG. 29.

tamped about the base of the pole first, and care must be taken to see that it is firmly packed on all sides of the poles. Alternate filling and tamping of coarser material then follow till the hole is filled. After this has been done, dirt is tamped about the pole above the ground level, and serves as a watershed which will drain surface water away from rather than

allow it to seep down about the base of the pole. Such a watershed should be not less than 6 inches high at the pole, and should extend outward from the pole to a distance somewhat past the edges of the hole.

Methods of Strengthening.—It not infrequently happens that poles may be of such material or may be so placed that in themselves they are not of sufficient strength to withstand the strain imposed upon them by the line wire, and in such instances it of course becomes necessary to re-enforce them in such a manner that efficiency of the line will not be impaired.

Guys.—These are of twisted wire and are usually cheaper than braces. They consist of at least two wires (of the same gauge as the line wire) twisted together and are of a length sufficient to reach from the bracket to a point on the ground at a distance from the pole equal to the pole's height above ground. See Fig. 30. An anchor block, or "dead man," is buried at a depth of 3 feet, which allows the eye of an ordinary anchor rod to extend above the surface of the ground. After the upper end of the guy wire has been made fast to the pole by two turns about it just below the bracket and twisted not less than six times about itself, the lower end is brought to the anchor rod by means of the Buffalo grips, which regulate the tension, and is then passed through the eye and back on and twisted about itself in not fewer than six turns.

Braces.—Brace poles should have a minimum butt diameter of 8 inches. They should be set at least 3½ feet below the surface of the ground, against a solid bottom, and at a point from the pole equal in distance to one-half the pole's length. See Fig. 31. When so set the upper end should strike the pole three-fourths of the way up. Hewing, for the purpose of making a tight joint where the brace strikes the pole, should always be done on the brace and never on the pole. A ⅝-inch galvanized bolt is passed through both timbers just above the lower edge of the braces and serves to hold the two together.

Use of Guys and Braces.—These are used on the first and last poles of a line, at approaches to crossings, at the ends of spans from 300 to 500 feet long, and on poles set in very steep hillsides or along curves where the pull exceeds 30 feet. They may be used at other points as circumstances demand.

Re-enforcements.—Poles may be re-enforced as shown in Fig. 32. This method of bracing is used when conditions prohibit

the use of guys or braces or when poles have become weakened through decay. Stubs should be of cedar, although other dur-

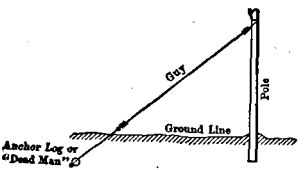


FIG. 30.—Guy for telephone pole.

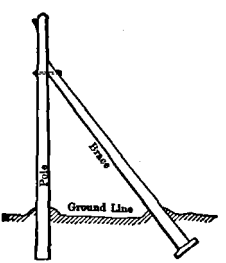


FIG. 31.—Brace for telephone pole.

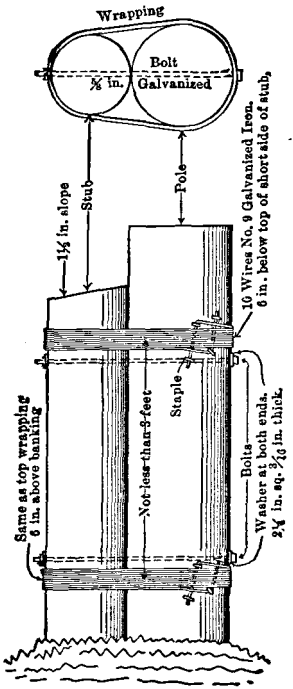


FIG. 32.—Re-enforcement with stub.

able woods may be used when this is not available, and should have the following approximate dimensions:

Length of pole, in feet	18	22	25	30
Length of stub, in feet	9	9	9.5	10
Top diameter of stub, in inches	7	7	8	8.5

They should be set as deep as the pole and on the side where line strain will tend to pull the pole toward rather than away from them.

Methods of construction are explained in the figure.

Stubs—These are used where a guy crosses a road or trail and are shown in Fig. 33. They are guyed the same as a pole.

LAYING WIRE

No more wire than can be hung in one day should be laid out at one time. It should be cut at points where the line is to cross a road, trail, or other path of travel and the loose ends should be fastened back out of the way. Unless this is done the wire should be suspended in such a manner that vehicles or travelers may pass beneath it without difficulty. Care must be taken to see that all short kinks are either straightened or cut out and the wire spliced before it is stretched, this being especially true of hard drawn copper wire. Deep nicks, stretches of rust, and all other especially weak spots should be cut out, but at the same time care must be taken to keep the number of splices at a minimum if efficient service of the line is to be secured.

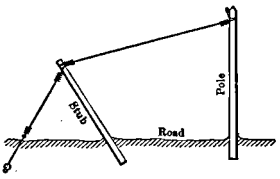


FIG. 33.—Stub for telephone pole.

The coil of wire to be laid out should be placed on the reel in such a way that the loose end will run from the outside and a few rounds should be run off in order to ascertain definitely whether this end of the wire has been loosened. If the topography and travel facilities of the country permit, the reel may then be placed in the rear of a wagon and hauled over the right-of-way after the loose end has been tied to some stationary object. Otherwise two men may carry the reel and lay out the wire after the same manner. If neither of these methods is practicable then the reel may be firmly set and the wire laid out with a horse. This can be done by tying a 12- or 14-foot rope to the end of the wire and "dallying" the other end at the saddle horn. The practice of looping the wire itself about the horn is one to be avoided; in case of accident the wire can not be released in time to avert injury either to the horse or the rider.

Animals not trained to pull under the saddle may be worked

in harness, the wire being looped into the center clip of a single tree and laid out quickly and easily. It is always advisable, however, for one man to remain at the reel to see that no tangles occur as the wire is run off. It invariably happens that without some means of regulating the speed at which the reel revolves several turns of wire are thrown off at once and the consequent tangle necessitates numerous splices or else total loss of all the turns so tangled. It is also advisable, and even necessary, that a prearranged system of signals be agreed upon by the man at the reel and the one paying out the wire.

Care must be taken, also, to see that the wire is laid on the proper side of poles if extra work in the way of replacing or cutting and splicing is to be avoided.

After the wire has been laid it may be hung over the brackets, ready for stretching and tying, by means of either a slender pole, to the ends of which a horseshoe has been attached so that when the pole is erect the heels will point upward, or by using a long slender forked pole.

CLIMBING

The climbers or hooks are strapped securely to the legs just below the knees and again at the ankles with the loose ends of the straps projecting to the rear as shown in Fig. 34. The safety belt is buckled about the waist comfortably tight and all the tools to be used in tying or otherwise working on the wire at the insulator are placed in their respective loops. One end of the safety strap is snapped into the ring at the left side of the belt and the other is allowed to hang loose until the climber reaches the desired height on the pole. This is usually when the chin is about on a level with the insulator if tying is to be done. In using the hooks no attempt should be made to grip the pole with the knees, as this will force the hooks out of the wood and cause the climber to slide suddenly downward.[1] The knees must be bent outward away from the pole and care

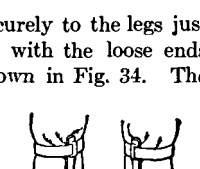


FIG. 34. — Method of attaching climbers or "hooks" to the legs and feet.

[1] Known in the lineman's vernacular as "burning the pole."

must be taken to fix each hook firmly into the pole before another step is attempted. This is done by a sharp, vigorous thrust with the foot directed diagonally downward at the pole. The body is kept well away from the pole and parallel with it from the waist up. Crooked or leaning poles are climbed on the upper side of the crook. When the desired height has been reached both hooks are struck into the pole at about the same level and the pole is securely grasped with the right hand and arm. The safety strap is passed around the pole with the left hand and caught with the fingers of the right. The left hand and arm then grasp the pole, and the safety strap is hooked into the right side of the belt with the right hand. The lineman then settles his weight backward against the belt and downward on the hooks, keeping his body rigid and well away from the pole. In this position he is able to make a tie without difficulty.

POLE STEPS

These are used in poles over 35 feet in length. Beginning at a point 6 feet above the ground they are set alternately along

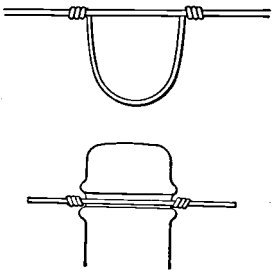


FIG. 35.—Horseshoe tie for iron wire.

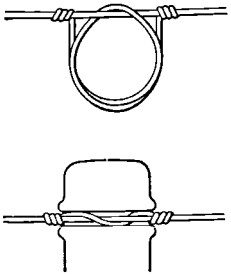


FIG. 36.—Figure 8 tie for iron wire.

opposite sides of a pole and are spaced 3 feet apart, making steps 18 inches high. As a general rule they are screwed into the pole before the latter is raised. The most convenient method of inserting them is to start holes $^1/_{16}$-inch less in diameter than the screws. They may then be screwed or driven in without difficulty. If they are to be used in large trees they should be placed at about right angles to each other rather than on exactly opposite sides of the tree.

TIES

Horseshoe.—This tie is illustrated in Fig. 35. It is the most common tie used, and is especially convenient in rural and secondary lines. The tie wire is of the same gauge as the line wire and is cut 10 inches long. Each end is given not less than three

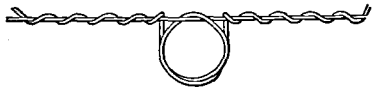


FIG. 37.—Figure 8 tie for hard-drawn copper wire.

close turns about the line wire and the projecting ends are then clipped off short in order to avoid weakened transmission as the result of "leakage." Such ties are for use on iron wire and are not adapted to tying hard-drawn copper wire.

Figure 8.—The wire for this tie is also of the same gauge as that of the line wire, but is cut from 24 to 30 inches long. When used on iron wire, it is constructed as shown in Fig. 36, but if hard-drawn copper wire is to be tied it is made as shown in Fig. 37.

A variation of this tie is shown in Fig. 38, but is not used as extensively as either of the preceding ones. However, it may be used to good advantage in tying hard-drawn copper wire, and in such a case the ends are disposed of as shown in Fig. 37. The tie wire is cut 18 inches long.

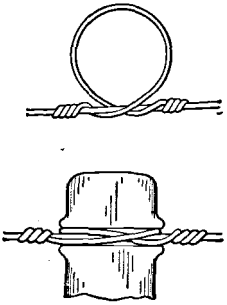


FIG. 38.—Tie for iron wire. (Seldom used.)

Swinging.—These ties are constructed as shown in Fig. 39 and are for use in lines hung from swinging insulators. They are attached to the line wire not nearer than 6 inches to the insulator and are cut about 20 inches long.

SAG

This term has reference to the distance below the horizontal to which a line wire should reach at or near the center of the span. The table of sag necessary to allow for galvanized

iron wire, hard-drawn copper wire, and for lines hung on trees, will be found on page 355, Appendix. The object of sag is to permit regulation of the tension of the wire during hot or cold

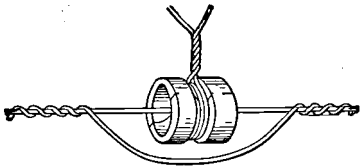


FIG. 39.—Swinging insulator.

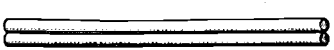
weather. In no case should it be less than that given in the table.

SPLICES

In Galvanized Iron Wire.—If a splice is to give the best service it must be as tight as possible and projecting ends must be cut away close up. Otherwise the transmitting efficiency of the line will be weakened through "leakage" and communication

Hook.

Western Electric joint. For iron wire.



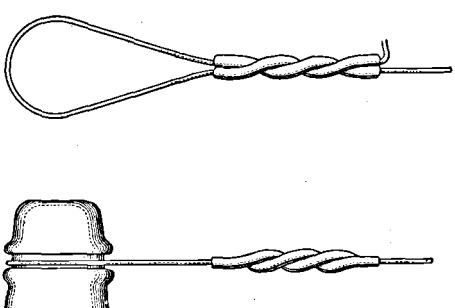
Hard-drawn copper wire spliced by use of sleeve.

FIG. 40.—Splices.

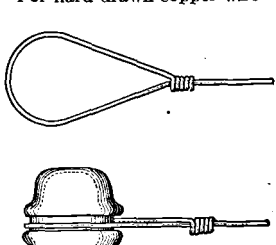
will be greatly impaired. The process followed in constructing a splice for this variety of wire is illustrated in Fig. 40, and is known as the "Western Electric" joint. The wire ends are

run through the connectors from opposite sides and are then given five turns about each other. Another method is to use two pairs of connectors and turn them in opposite directions or else hold one stationary and turn the other.

In Hard-Drawn Copper Wire.—Splices in this wire are made as shown in Fig. 40. The wire ends are inserted in the sleeves from opposite sides and ends and are then given not less than



For hard-drawn copper wire.



For iron wire.

FIG. 41.—Dead ends.

three nor more than four turns. The projecting ends, which should not exceed 1 inch in length, are turned back upon themselves. The sleeves should not be used in making splices in galvanized iron wire, as corrosion will result and weaken the wire.

The Hook Splice.—This splice, also shown in Fig. 40, is the very poorest sort of makeshift and should not be used under

any circumstances. Two or three of them in a line will so weaken the transmitting powers as to render communication almost impossible.

DEAD-ENDS

These are used at the terminals of lines, on poles next to railway or underground crossings, and at the junctions of switch lines with main lines. They are constructed as shown in Fig. 41. If hard-drawn copper wire is to be dead-ended the method is the same as shown in Fig. 41, where a half-length sleeve is given one and one-half turns.

APPROACHES AND CROSSINGS

Forest Service lines approaching other lines for the purpose of crossing them are dead-ended at either side. This is especially important if the crossing span is to be very long, in which case it is also dead-ended and connected to the main line as shown in Fig. 42. Such crossings are to be over other lines, unless the latter will be kept in good repair, and not allowed to fall across the Forest Service line. Power-transmission lines or electric-light lines are crossed underground, the nearest poles being set not less than 150 feet from them. These crossings should be taken up in detail with the proper office and specific instructions obtained as to the proper method of construction.

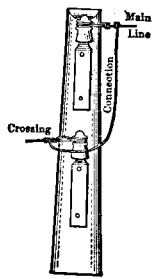


FIG. 42.—Dead-ends at crossing.

Spans crossing railroads must be suspended from poles set far enough back from the track so they will not reach it in case they fall. Ordinarily they should be braced or guyed from a direction that will prevent them from falling toward the track. The line wire is dead-ended at either side and two insulators are used, as shown in Fig. 42.

Spans crossing wagon roads must be suspended at a height that will permit the passage of traffic beneath them.

All approaches to crossings are at right angles to the line or road to be crossed; unless the ends of the crossing spans are dead-ended they are tied with the figure 8 tie; and if the spans are to be 500 feet or more in length, specific instructions as to the proper method of crossing should be obtained.

CONNECTIONS

Branch lines connecting with Forest Service lines are dead-ended on a separate insulator. They are left long enough to supply the connection wire, as shown in Fig. 43, and this is given at least seven turns about the main line if galvanized iron wire is used. Hard-drawn copper-wire connections are made as shown in Fig. 44.

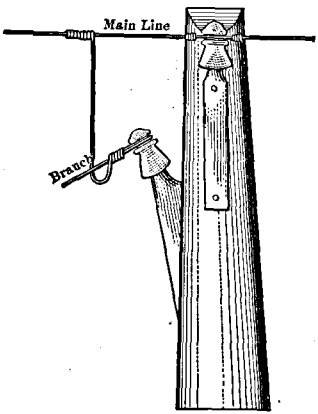


FIG. 43.—Branch-line connection. Iron wire.

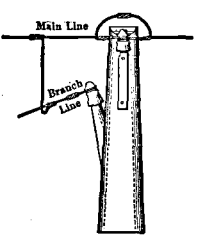


FIG. 44.—Branch-line connection. Hard-drawn copper wire.

LIGHTNING RODS

These are of the same gauge wire as the line wire and are attached to the poles before the latter are set. They are cut 3½ feet longer than the pole to which they are to be stapled and a 6-inch length is allowed to project beyond the upper end, or past the ridge of the pole roof. This is then bent back and twisted about itself, leaving a 3-inch extension above the pole. The extra 3-foot length is coiled or wound about in the shape of a clock spring and is stapled to the squared-off butt of the pole. The wire is then stapled along the pole one-quarter of the way around from the insulator. It must not be allowed to come in contact with the line wire or grounding will be the result. Ordinarily one should be attached to every tenth pole, but if the line follows a route which is greatly exposed to atmospheric disturbances one should be supplied at every fifth pole.

OTHER LINES

Forest Service lines hung on the same poles with other lines should be fastened at least 2 feet above the latter. They should never under any circumstances be hung on poles carrying power lines or other wires heavily charged with electricity.

TREE LINES

Where trees are used in lieu of poles the line is hung to them by means of swinging insulators, as shown in Fig. 39. These consist of two duplicate pieces of porcelain which when properly fitted together resemble an ordinary "spool" or "knob" insulator, except that the groove passes around the center instead of at one end. Each piece is fitted with a shallow hole at one corner and with a short tenon at the corner diagonally opposite. These prevent lateral displacement of the halves. Each half is also fitted with a semicircular, well-glazed, lengthwise groove through which the line wire passes when the halves are fastened together. After they have been fastened about the line wire they are suspended from long tie wires in such a way that they may swing to a distance of from 8 to 24 inches, farther if necessary. They were originally designed as a means of allowing the wire to slide through its support and not be broken by the swaying of the tree. However, the line wire seldom slides through them, but finally causes the tie wire to break at or near the tree as the result of continuous bending backward and forward. This trouble may be overcome by attaching a wire ring to the tree and fastening the tie wire into it. This ring may be made by twisting a piece of wire about a hammer- or hatchet-handle. Another objection to the use of such insulators is the fact that when the line wire does slide through them it becomes worn at that point and finally breaks. It is assumed that when they are used, trees falling across the line will not break it, but that the sag from several spans will accumulate at that place and allow the wire to be borne to the ground. This is exactly what occurs if the line is properly hung. Such lines are tied at about every seventh pole or tree by being fastened to an insulator on a bracket. These ties are of No. 12 gauge wire instead of No. 9, the difference in gauge allowing the tie wire to break before the line wire does. The same gauge is also used in tying every third swinging insulator. Other ties are of No. 18 gauge seizing strand.

TELEPHONES

Ohms Resistance of Ringer Coils.—The standard telephone used by the Forest Service is of 2,500 ohms resistance, but when Forest Service lines are connected with other lines the ringer coils in both the telephones and extension bells should have the same resistance as those on the line connected with. In some instances it may therefore be necessary to use instruments having 1,600 ohm ringers.

Protection.—The protector adopted as standard by the Forest Service is known as No. 60–E and is used where there is no exposure to high-tension circuits, such as power or electric-light lines. If exposure to lightning is especially great a No. 47–A line fuse is used in addition to the No. 60–E protector, but should be so placed that the wire nearest the line may fall away when the fuse is blown.

The same combination protection is used where there may be exposure to lines of high-tension voltage except in cases where the voltage may exceed 1,800. In that event specific instructions are to be obtained as to what method of protection should be used.

INSTALLATION[1]

Dead-Ending the Line Wire.—The dead-end bracket should be attached to the side of the building at a point as near the proposed location of the telephone as possible. In attaching the line wire to the dead-end insulator it is left long enough after dead-ending to be bent back on itself for a distance of at least 2 feet and is then run down to and connected with the fuse as shown in Fig. 45. The fuse should be suspended at a point low enough to allow easy access to it when replacement becomes necessary.

Connection of Fuse with Set.—This connection is shown at 1 in Fig. 45 and should be of No. 14 Brown & Sharp gauge wire weather-proofed. The insulator shown at 2 is the regular No. 4½ porcelain knob attached to the wall with a No. 18, 3-inch, flat-headed iron screw. The tie wire should be insulated.

[1] For installation of sets on metallic circuits, wiring, and installation of outside sets, and other information, see Forest Service manual. "Instructions for the Building and Maintenance of Telephone Lines on the National Forests."

Drip Loops.—These are made as shown at 3 and are provided in order that water may not follow along the wire into the tube, shown at 4. Such loops should be at least 2 inches deep.

Tubes.—These are also of porcelain and are of different lengths and diameters. They are used as conveyances for wires which are to be passed through walls and they also act as extra insulation for such wires. In outside walls they should be set with the inner end higher than the outer end. This prevents water from following along the wire into the building. They may be set horizontally in interior walls.

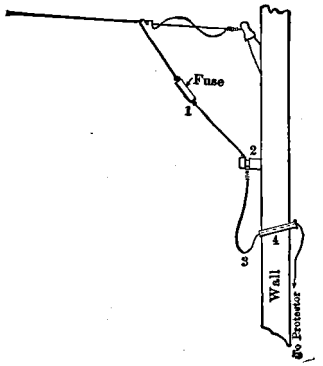


FIG. 45.

Connections at Protector.—Usually the protector is attached to the inside of the wall at a point directly over the telephone. The line wire connects at the upper side and the line terminal in the set connects at the lower side.

Connections in the Set.—As a general rule all telephone sets come ready wired and the terminals in the ones used by the Forest Service are lettered "Line 1" and "Line 2." The line wire is connected with the former and the ground wire with the latter.

Ground Rods.—The standard ground rod used by the Forest Service is a ½-inch iron rod 5 feet long fitted with a copper wire for connection with the ground wire of the set. When possible to do so this rod should be driven its full length into the ground. At any rate, it must be driven to moist earth if good grounding is secured. It need not necessarily be driven immediately next to the building but may be set at a point several rods away. If the character of the ground is such that no suitable place can be found for the ground rod, a 50-foot length of wire may be closely coiled and buried at a depth which will insure its contact with permanently moist earth. One end of this wire is then connected with the ground wire of the set. The hole in which the wire is buried should be filled with charcoal or very fine dirt.

Joints and Splices.—All joints and splices, both inside and

outside of the telephone, should be wrapped with tape, except those at the terminals in the set. If this is done they need not be soldered.

Connection of Batteries.—Ordinarily all telephones are fitted with dry batteries which are connected with each other, as shown in Fig. 46. They are connected before being placed in

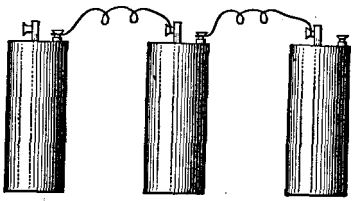


FIG. 46.—Connection of batteries.

the box. If the latter is wide enough to accommodate three batteries this number should be used in preference to two.

To Test Dry Batteries.—The easiest method of ascertaining whether or not a battery is exhausted or "dead" is to press the heel of a knife-blade firmly against the binding post at the edge of the battery and the point of the blade against that portion of the battery in which the other binding post is fastened. If the portion touched with the point of the blade "fries," sparkles, or smokes the battery is still "alive." If the application of the knife-blade has no perceptible effect on it, then the battery is too weak to give good service and should be replaced with a new one. Another effective test is to place the binding posts of one battery against opposite posts of another. A spark will result if the batteries are alive.

TELEPHONE TROUBLES

The following "troubles" occur most frequently and as a general rule may be immediately remedied by making the necessary repairs or adjustments:

(1) Rings and communication received but not transmitted: Loose connections or broken wires in batteries or transmitter or both.

(2) Rings not received: Broken wires or loose connections in ringer or improper adjustment of clapper between bells.

(3) Rings transmitted but not received: Loose connections

or broken wires at connection of line wire with set, ground rod or protector, contact of line with trees, or other grounding agents.

(4) Crank turns hard and rings are inaudible and not transmitted: Usually due to crossed wires.

(5) Crank turns easily, rings audible but not transmitted: Broken or poor ground connections, loose connections of outside with inside wiring, broken line wire, poor connection at terminals or protector.

(6) Indistinct transmission and receiving: Loose connections, improper joints or splices, worn-out batteries, or faulty grounding.

(7) Difficult ringing, transmission, and receiving: Poor joints, faulty ground, line wire of too light a gauge, too many telephones on the line, too many receivers down, contact of line with trees, branches, or poles.

(8) Good transmission, poor receiving: Loose connection or broken wires in induction coil or receiver hook, broken wires in receiver or receiver cord, damaged or dusty diaphragm.

(9) No transmission or receiving: Broken or disconnected line wire, crossed or broken wires in the set, no ground connection, improper terminal connections.

(10) Intermittent transmission and receiving: Loose line connections, intermittent contact of line wire with grounding agents.

DAMAGE TO OR DESTRUCTION OF TELEPHONE LINES

Section 60 of the Act of March 4, 1909, as quoted on page 31, U. B., 1915, provides as follows:

"Whoever shall willfully or maliciously injure or destroy any of the works, property, or material of any telegraph, telephone, or cable line or system, operated or controlled by the United States, whether constructed or in process of construction, or shall willfully or maliciously interfere in any way with the working or use of any such line or system, or shall willfully or maliciously obstruct, hinder, or delay the transmission of any communication over any such line or system, shall be fined not more than $1,000 or imprisoned not more than three years, or both."

TRAILS

Local conditions so completely govern the work of trail construction as to make a set of definite rules impracticable, but

nevertheless certain general rules can always be followed with more or less success, and it is felt that a few suggestions concerning the actual work in the field will not be out of place.[1]

Purpose.—Trails are constructed in National Forests for three general purposes, viz.: (1) Transportation facilities; (2) travel facilities; (3) protection facilities. The first is constructed between points where more or less traffic in the shape of supplies and other commodities passes in transportation by pack-animals. Such a trail would correspond to a class A trail as designated in the Forest Service and would usually follow some natural line of travel, such as a main valley, where eventually it could be widened into a road with little further expense. It would have a maximum grade of 15% with a standard grade of 6%. The second would be constructed chiefly as a means of access from one secondary point to others, would not exceed a 20% grade, maximum, with a standard grade of 12%, would not be built in anticipation of its future reconstruction as a road, and would correspond to what is known in the Forest Service as a class B trail.

A trail leading to some isolated point not of sufficient importance to justify heavy expenditures in trail construction or to demand frequent visits or quick access would be a class C trail, and might have a grade as much in excess of 20% as could be negotiated by pack- or saddle-animals, the standard grade, however, being 18%.

All trails, in addition to facilitating transportation and travel, may also serve as means of fire protection by providing stretches of ground free from inflammable material.

Preliminary Survey.—The three features of greatest importance in the preliminary survey for a trail are: (1) Directness of route; (2) uniformity of grade; and (3) cost of construction as compared with the economic value of the completed trail. Obviously the adoption of an indirect route between termini when a more direct and just as good a route is possible cannot be justified, nor are numerous and unnecessary descents justifiable when ascent is the objective. Cost estimates must be held to a limit compatible with the importance of the trail, *i. e.*, ex-

[1] See Trail Manual, 1913, Preliminary Draft. by F. A. Silcox. District Forester, District No. 1. See also the manual, Trail Construction on the National Forests, 1915.

penditures sufficient for construction of a class A trail should not be contemplated in construction of a trail to be of minor importance when completed. On the other hand, however, proper construction of a trail intended to be used chiefly for transportation purposes should not be neglected to an extent that will leave the trail in no better condition when completed than a class B or C trail. Cost of construction is necessarily determined by the nature of the route to be covered, the amount of blasting and grading to be done, the number and sizes of bridges, culverts, drain ditches, retaining walls, and switchbacks required and the amount of swamping to be done. It also includes the cost of the preliminary survey, which, under ordinary conditions, should not exceed 5% of the entire cost of actual construction.

Locating the Route.—In most instances where a trail must cross hilly or mountainous country the work of locating the route should begin at the high points and proceed down-hill, this method of operation facilitating advance observations and obviating extra work often incident to up-hill surveys. The preliminary route or routes should be marked only at points sufficient to indicate the line for possible future reference in the final survey, blazes being very light and not cut through the bark, and stakes being small and only temporary in nature. Later, after all trail lines have been run and the final survey has been made, this should be marked plainly with blazes cut through the bark or with strong durable stakes set firmly in the ground at frequent intervals.

Such blazes or stakes may be scribed or otherwise marked with any information the construction crew may require for proper grading or other work, care being taken of course to see that the foreman will readily understand what is meant by certain locations of or data on stakes or blazes.

Grade.—To determine the grade of a trail between objective points the rise, or difference in elevation, between those points is divided by the corresponding length of trail minus the total length of the level stretches it may cover. Thus, letting R represent the rise, T the length of trail, L the total length of levels, and G the per cent of grade, the formula for such a calculation would be

$$\frac{R}{T-L} = G.$$

Therefore, assuming that a trail ½ mile, or 2,640 feet, in length ascends 375 feet and covers levels aggregating 140 feet in length, the per cent of the grade is found thus:

$$\frac{375}{2{,}640 - 140} = 15\%.$$

Clearing.—Trees, brush, and saplings should be cut out to a distance far enough back on either side of the trail to allow uninterrupted progress of pack- and saddle-animals. Limbs overhanging the trail should be removed till at least an 8-foot vertical clearance is secured. These should not be merely "bobbed" or "dehorned" so that long stubs are left projecting toward the trail, but should be cut away close up to the tree trunk. Stumps growing along the lower edge of a side-hill trail frequently may be utilized as braces in retaining walls of minor importance but should not be relied upon to form parts of heavy walls that can be repaired only with difficulty. If they are to be left along other portions of the trail they should be cut low enough to allow plenty of room for stirrups to pass above them. Large trees growing directly in the route chosen for the trail to follow should, in all ordinary circumstances, be passed around rather than felled. If they are felled the stumps must be either passed around anyhow or else grubbed out, and in this case there always arises the question whether or not grubbing is more economical than deviation of the trail.

Large roots or small stumps uncovered in grading and left projecting above ground or from the upper bank should be cut out in such a way that remaining portions cannot possibly interfere with travel.

Disposal of Débris.—A fixed rule in the Forest Service is either to burn all refuse resulting from clearing and grading or else pile it and have it ready for burning at a later date if circumstances prohibit burning at the time the trail is constructed.

GRADING

Blasting.—A discussion of this subject will be found on pages 74 to 85, inclusive.

Tools Required.—The number of tools required in building a trail depends upon the number of men to be employed and the nature of the ground to be worked over, and about the only

general rule that can be followed in outfitting a crew is to see that each man is provided with at least one tool. In addition to such a list it is also well to supply at least one extra tool, or accessories, of each variety to be used most and which will be most liable to damage. This is especially true of handles if suitable material for improvised handles cannot be secured along the trail.

Plows.—Only in rare cases can trail grading be done by means of teams.

Occasionally, however, one horse, hitched to a light plow, can be used to advantage in breaking ground which can later be raked or shoveled out or placed as desired. The most suitable plow for such work is what is known in the South, and, in fact, in most other sections, as a "bull tongue" or "Georgia stock," and which consists merely of a straight beam frame carrying a straight leg fitted with a 4-inch steel shovel from 8 to 16 inches long. A lighter variation of the bull tongue is known as the "calf tongue," which is only about 2 inches wide and which is designed for use on a bent leg. Another suitable form of shovel for such a frame is known as a "twister." This is about 6 inches wide by 12 long and bears a 3- or 4-inch wing which serves the same purpose as the mould board on a turning plow. The wing may be either right or left turning.

The best 2-horse turning plow for trail work is what is commonly known as a "side-hill" or "hillside" plow. The landside and mould board are so constructed that either may be used as the other simply by reversing their positions. They are released by raising a lock that holds them in position for plowing and can easily be turned by allowing the team to tip the plow as the turn is made for cutting the next furrow. The lock is fastened before the furrow is started. Constructed in this manner, the plow may be used to throw dirt down-hill in plowing in either direction along the trail.

If a side-hill plow is not available, then an Oliver chilled No. 13 turning plow is recommended. This will cut a clean 8-inch strip without difficulty, is light, and can be easily handled on steep hillsides, and will be found preferable to heavier plows cutting wider furrows. It is especially suitable for work in ground full of stones and roots. The share fastens to the frog with only one bolt, and this is threaded in such a way that the tap must be turned to the left to be tightened. Being threaded

in this manner the tap is tightened rather than loosened if it accidentally slides along on rough ground. Another advantage of this plow is that when dull, the share, being chilled, may be sharpened by chipping it with a hammer, the blows being directed against the edge in line with the upper surface, thus breaking the chips from the upper side and beveling the share so it will feed into rather than out of the ground. If the chips are knocked from the under side of the share the bevel will be reversed and the plow will jump or feed upward. The share cannot be heated and beaten out to a thin edge.

Another form of 2-horse plow very suitable for rough work, and especially effective in breaking out roots and small boulders, is known as a "coulter." It consists simply of a pointed steel leg, square, round, or shaped like a knife-blade, thrust through the beam and used in breaking ground. It is designed only for breaking hard or rough ground and cannot be used in moving dirt.

In using any form of plow in ground where roots or stones may be encountered frequently the plowman must exercise great care in avoiding broken root ends as they snap back from the plow. Carelessness in this respect may result in severe injuries to or even fractures of the legs. He should also walk behind rather than between the handles, since these are often forced suddenly sidewise or upward or downward as the plow-point strikes stones or slips over or under roots, and at such times may inflict painful or even dangerous injuries on the body. He should also remember that a bull tongue, twister, or coulter is so constructed that it is lowered into the ground by downward pressure on the handles and is released by raising the handles, while a turning plow, being fitted with a long point, landside, and share, can be forced into the ground with much less difficulty if the handles are gradually forced slightly upward or toward the side on which the landside works, which, in a regulation turning plow is to the plowman's left. The plow can be released quickly and easily by sudden downward pressure on the handles or by turning the plow sidewise and downward on the share side. The latter operation can be performed without difficulty by seizing the left handle with both hands and thrusting the plow to the right.

The lateral direction and the depth to which a turning plow may be made to run in rough ground is regulated to a certain extent by means of the double clevis fitted to the end of the

beam and supplied as a means of attachment for the double tree. This is known as an "end clevis" or a "plow clevis." On steel-beam plows the part attached to the beam is in two pieces, one piece fitting to each side of the beam. For a wooden beam it is made in one piece and to fit over the end of the beam. At the forward and perpendicular end a number of holes, one below the other, provide means for attaching that part of the clevis which fastens to the double tree, and it is by means of these holes that depth is gauged. Hitching into the lowest hole serves to raise the point of the plow and thus permits shallow plowing, while hitching into the upper hole forces the point downward and allows deeper plowing. Intermediate depths are provided for by the other holes. Lateral direction may be gauged by attaching the double tree to the horizontal part of the end clevis. Hitching into the hole farthest to the left forces the plow to the right and causes it to "cut narrow." Using the hole farthest to the right makes the plow "take to land" and cut wide, or "cut and cover," this term applying to work in which a narrow strip of uncut ground is left between furrows and covered over with fresh dirt.

In making the turn at the end of a furrow preparatory to cutting the next furrow, a turning plow should not be slid along on the edge of the share. If it must be slid at all it should either be slid on the heel of the landside, which is made extra heavy for this use, or else thrown completely over on its left side and dragged. Dragged in this manner it is always in such a position that it may be easily set upright by seizing the upper or right handle with the right hand and raising the other handle to the left hand.

A bull tongue, twister, or coulter, having no long horizontal point, share, or landside, may be turned about on the point as on a pivot.

In turning any plow sufficient downward pressure should be applied to the handles to raise the end of the beam to a point where it will hold the double and single trees high enough to prevent the animals from stepping over or entangling themselves in the traces. Turning may also be facilitated by tipping the beam away from the team after it has been raised.

Weights placed on a turning plow to assist in holding it in rough ground should be attached near the end of the beam rather than over the leg. When they are placed on bull tongues,

twisters, or coulters they should be fastened immediately over the leg.

Plowing in very rough ground will be found much easier if one man drives while the other holds the plow. The driver should keep his animals under complete control, should hold them to a slow, steady walk, avoid exciting them, and before starting them again should give them ample time in which to regain their footing and equilibrium after the plow has been brought to a standstill by contact with a root or boulder. The sudden violent jars transmitted to the animals when the plow suddenly strikes a stationary object is not only severely painful and nerve-wracking, but may even so irritate a team that proper management is a difficult matter. It is therefore imperative that the collars fit properly, that all parts of the harness are substantial and properly adjusted, and that careful horsemanship be observed in all respects. Excited or irritated animals should be given a complete rest while the driver and plowman turn their attention to other lines of work, such as removing roots, stones, or brush.

Graders.—Trails are so seldom constructed in country where graders can be used that these implements will not be discussed here.

Picks.—Common "railroad" picks, weighing about five or six pounds, fitted with 34-inch handles, and costing from fifty cents to a dollar each, including cost of the handle, will be found very effective in loosening dirt, but cannot be used to advantage in removing it. Care should be taken to supply several extra handles for the crew, many members of which are often found to exercise little or no judgment in their use of a tool or tools. Handles cost from fifteen to twenty-five cents.

Mattocks.—These should have 16-inch blades with 6- or 8-inch axes and should never be used in extremely hard or stony ground. They are designed primarily for dirt-moving rather than loosening. They weigh and cost about the same as picks.

They will be found especially suitable for grubbing out roots, cutting brush beneath the ground surface, and taking out roots and stumps along the bank.

Combined Picks and Mattocks.—As their name indicates, these are so constructed as to provide a pick and mattock in one tool, and if limited funds demand strict economy in the

purchase of tools their use is recommended in preference either to picks or mattocks. They can be used with equal success as either, are strong and durable, and weigh and cost about the same as picks.

Railroad pick.

Mattock.

Combined pick and mattock.

Pick or mattock handle.

Grubbing hoe handle.

Planter's hoe handle.

FIG. 47.

Grubbing Hoes.—A heavy grubbing hoe may also be used effectively in cutting roots and brush and moving loose material. They are heavier and more durable than mattocks and can be used to better advantage in hard or stony ground. They should weigh not less than three and one-half pounds, should be of forged steel, fitted with an adze eye and a 36-inch bent handle, and should cut 3½ inches. Their cost, including that of the handle, is about the same as that of a pick.

A light variety, having a thinner but much wider blade, and known variously as "planter's," "cotton," "hazel," and "eye"

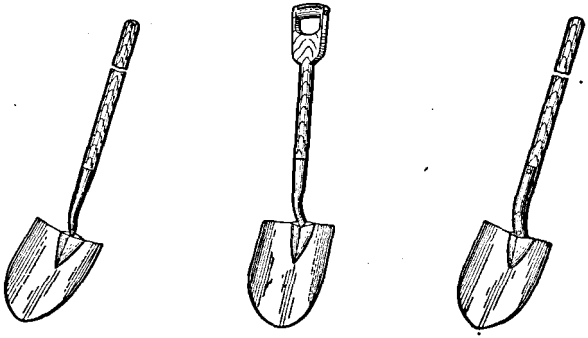
hoe, made for use on a 4-, 5-, or 6-foot handle, will be found very effective for cutting grass roots and fine brush or in leveling

Grubbing. Planter's.

FIG. 48.—Hoes.

uneven ground. They cost somewhat less than the heavier grubbing hoes.

Shovels.—Shovels for general use should be fitted with long handles and should not exceed five pounds in weight. Blades



Socket shank. D-handled shovel. (Socket shank.) Strap shank.

FIG. 49.—Long-handled shovels.

should be about 9 by 12 inches in size and should bear socket shanks in preference to strap shanks, new handles being fitted in the former with much less difficulty than in the latter. The cost is slightly more than for strap shanks, but such shovels prove much more economical in the long run. The cost varies from sixty-five cents to $1.25.

At least one short D-handled shovel should be provided each crew for work in close quarters where a long handle cannot be used to advantage, such as in work about stumps or boulders or along ditches and banks. It weighs somewhat less than the long-handled variety, but the size and cost are about the same. A socket shank is recommended.

Pinch Bars.—These implements, if fitted with wedge points, are known as "crow" bars, but if beveled only on one side of the point have "pinch" points and are known as "pinch" bars. The pinch point renders them more effective than a wedge point in forcing them under and prying up heavy boulders, and they

Crowbar.

Pinch bar.

FIG. 50.

will be found more generally satisfactory than crowbars. They should be 5 or 5½ feet long and should weigh about twenty pounds. The cost varies from seventy-five cents to $1.25.

Rakes.—These will be found very useful in leveling the tread and in removing gravel and fine brush from the trail. Asphalt rakes, which have extra long shanks fitted into heavy handles, will be found most suitable for rough trail work. They weigh approximately four pounds and cost from fifty cents to one dollar.

Axes.—A description of the best axes for general trail work will be found on page 170.

Bush Hooks.—These should be about 12 inches long over all, should have 2-inch blades and 6-inch cutting edges, and should be made to attach to regulation bush snathes. They will be found very effective for use in cutting out tangles of briars, dense thickets, and other growths not easily reached with the ax. Made of a good quality of tempered steel, they weigh about one pound and cost from fifty cents to one dollar.

FIG. 51.—Bush hook.

Brush Forks.—Ordinary hay forks, or "pitch" forks, will prove very satisfactory in removing or piling fine brush, such as brambles, sage brush, buck brush, and small seedlings. They should have 5-foot handles, three 12-inch tines, and substantial ferrules fitted over the sockets. They weigh about three pounds and cost from fifty cents to one dollar.

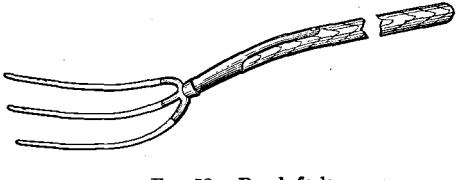


FIG. 52.—Brush fork.

Use of Picks, Mattocks, and Other Tools.—About the first request made of a new man in any large construction gang employed in grading work where men must work close abreast of each other is to refrain from swinging the tool he is using, and thereby avoid the possibility of inflicting injuries on his fellow workmen. Picks, mattocks, grubbing hoes, axes, sledges, and all other tools ordinarily swung to one side in using, must, in crowded work, be raised straight up and dropped without any swing whatever. The practice of delivering a long, violent, swinging blow at hard or stony earth is to be avoided at any time. It is not only wearing on the workman, but in the majority of cases does not prove more effective than shorter and lighter blows. Such tools are not made for work that requires them to be used with such force, and if the foreman allows his men to use them in a manner not provided for in their construction he will soon find his repair bill out of all proportion to other expenses.

In average hard ground the workman will find that from twelve to fifteen blows per minute with a pick, mattock, or hoe will constitute a reasonable rate of speed in labor for him to maintain throughout an eight-hour day.

Shovels should not be thrust violently against boulders or into extremely hard ground, nor should they be used as a pinch bar or pick. They are not intended for such use, are not built to withstand such treatment, and may be quite easily battered, bent, or broken.

The easiest method of using them is to rest the lower hand against the upper side of the corresponding thigh as the knee is slightly bent, bring the other hand close in against the right hip, and thrust them into loose dirt by inclining the body sidewise and slightly forward. This relieves the back and arms of unnecessary strain by providing a fulcrum, through the medium of the thigh first mentioned, against which the loaded shovel may be operated.

A workman of average strength and endurance shoveling in this manner can remove on an average of ten shovelfuls per minute and throw or scatter the dirt to a distance of from 6 to 12 feet. If the dirt must be thrown upward to about the same distance the rate must be lowered to about eight or nine shovelfuls per minute.

Care of Tools.—Each man should be required to take his tool or tools into camp with him at the end of the day's work and to see that they are in proper repair for use the next day, this rule not applying, of course, to plows and scrapers if these are used.

One man should also be detailed to carry in the extra tools, his own tools being taken care of by one of the other men if the extras are so numerous or heavy as to make this arrangement desirable. By following such a plan of caring for his tools the foreman or Forest officer in charge will suffer fewer losses through theft, carelessness, and forgetfulness than if the tools are not so taken care of.

A grindstone, whetstone, files, and a portable forge should be supplied for sharpening purposes. The first two may be used in sharpening axes, bush hooks, and other keen-edged tools; blunt-edged tools may be filed; and the forge may be used in heating picks, drills, and other tempered tools for sharpening.

A plow to be left unused for considerable periods should never be left sticking in the ground, nor should it be removed and carelessly thrown on its side in such a position that men or animals may accidentally injure themselves on the point, the heel of the share, or the ends of the handles. It should be set up squarely and securely and all exposed cutting or turning portions should be well smeared with wagon-grease to prevent rusting. This precaution often obviates the necessity for preliminary plowing through sand or gravel before the plow will "scour." All taps used on it, especially the one that secures the

share to the frog of an Oliver chilled plow, should be kept tight and not allowed to work loose. Single and double trees when not in use should be laid near the plow or kept attached to it.

The brush fork, when not in use, should be set securely on the tine points, and in such a place that in their work men or animals will not accidentally displace it, and thus provide possible means of injury to themselves.

Rakes should either be set away in a safe place or laid teeth downward where men and animals need not pass over them in going about their regular work.

Bed.—The larger, coarser stones removed in grading and not needed in retaining walls are thrown into the bed first and are firmly settled and packed with loose dirt before filling progresses further. Smaller stones, coming from farther up on the bank, are then thrown in and likewise settled. By using this material at such a time it is not only removed from a point from which it might otherwise slide into the trail, but it is also utilized in making a substantial bed. Finally, all loose material is removed from the upper side and used to complete the bed and provide capping. Care must be taken to see that brush, stumps, and old logs are not made a part of the bed. If buried in the bed they will soon rot and leave the bed full of "sink" holes or otherwise in bad condition.

Retaining Walls.—Instances may occur where the nature of the ground to be worked over is such that stone for retaining walls cannot be secured from cuts or grades, but must be ob-

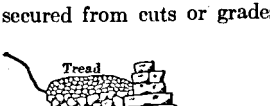


FIG. 53.—Cross section of trail showing construction of retaining walls.

tained elsewhere. In that event the man in charge must determine whether or not such material can be procured and put in place with less expense than would be required in grading out an extra wide bed which would require no retaining walls.

In any case, however, retaining walls should be of stone and should be constructed in a manner similar to that shown in Fig. 53.

The larger, heavier stones are placed on a firm foundation along the lower side of the trail, the lighter stones being used to complete the upper portions of the walls.

Walls should be drawn in slightly toward the trail as they are completed, and larger stones from the grade are then drawn down against them. They are thus built up with the bed in such a way that long stones may be used in tying them securely together, thereby allowing each to brace the other. Loose dirt is thrown in as the walls are built up, and is not, as may be supposed, kept till the last and then used as a cap.

Retaining walls may also be required along the upper side of a trail constructed through loose slides of broken rock.

Logs and brush should not be used for wall material unless it is absolutely impossible to secure stone. They are subject to decay and to destruction by fire, and their use invariably results in increased cost of maintenance.

Switchbacks.—These are short zigzag lengths of trail provided as a means of maintaining as nearly as possible a uniform grade up steep slopes and long sloping ridges known as "hog-backs," serving much the same purpose as landings in a flight of stairs where horizontal distance is so limited that uniform continuation of the flight in the same direction is impossible. They should be made as flat as possible in the turn, which should have a minimum width of 4 feet, and which should be protected by a log or a guard-rail so placed as to prevent short cuts across the turn by pack- or saddle-animals. The practice of building them around trees or high stumps is to be avoided. Under ordinary conditions their frequent use is unnecessary if proper care has been taken in determining the grade at which the trail is to ascend. Their construction materially increases the total cost of a trail and their presence renders travel more difficult than when a uniform grade is maintained.

Bridges and Culverts.—Since their construction adds materially to the first cost of trail construction and subsequent cost of its maintenance, these are to be avoided when possible. Deep cañons may be crossed by dropping the trail to the stream at a point suitable for a ford and ascending the opposite bank, thus doing away with the need of a bridge.

However, if a bridge must be built, care must be taken to see that it is erected on a substantial foundation that water will not weaken or remove. If the field man understands masonry,

and proper material and sufficient funds are available, he should by all means construct the piers and abutments either of stone or concrete. (For Concrete Construction, see pages 99 to 105, inclusive.)

Less permanent, though very reliable, piers and abutments may be made by laying up triangular log pens, pinning or otherwise locking the corners securely together, and filling the pens with loose rock or heavy boulders. Corner pins may be of iron or wood, but if the latter is used it should be of some tough variety, such as seasoned hickory or oak, that will not decay quickly. Pier pens should be placed in such a position with reference to the stream flow that the current may act directly against a corner rather than full against one side.

Bridges not to exceed 20 or 24 feet may be constructed as shown in Fig. 54. Over this length and of complicated design

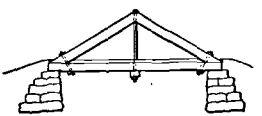


FIG. 54.—Short bridge.

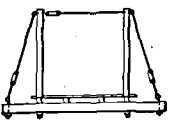


FIG. 55.—Method of guying bridge "rafters." (End elevation.)

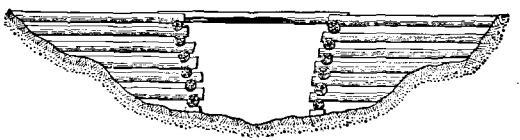


FIG. 56.—Log Bridge.

their construction should be left to an experienced bridge builder and will not be discussed here. Side braces or "rafters" may be tied together, as shown in Fig. 55, the tie being far enough above the floor, of course, to allow the free passage of vehicles beneath it.

Bridges to be built across permanent streams having long sloping banks may be constructed as shown in Fig. 56. None of the logs should be less than 10 inches in diameter at the small

end and all should be perfectly sound. Abutments should have substantial rock foundations that water will not undermine or wash out and the logs should be notched into each other preferably in the same manner in which house logs are notched. See Fig. 85. The sides flare outward toward the rear, and when filled with rock and earth serve as approaches. If the sides next the stream are gradually drawn in as the top is reached there will be much less danger of their collapsing if the foundations are disturbed.

Culverts should always be of stone when such material is available and may be constructed as shown in Fig. 57. Other

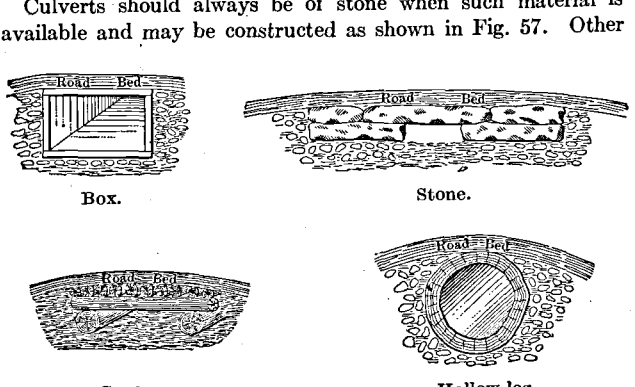


FIG. 57.—Culverts.

forms of culverts, only temporary in nature, are of poles, boxes, or hollow logs, and are also illustrated in the same figure. Poles of seasoned aspen or quaking asp (*Populus tremuloides*), or any of the cedars or junipers having a top diameter of not less than 8 inches, will be found quite durable, but most of the pines may be used in cases of emergency. Such structures are usually only for temporary use and do not justify heavy expenditures for material.

If circumstances prohibit the use of poles a very good substitute may be had by the use of puncheons. These are merely portions of split logs laid flat side upward and used in lieu of planks or heavy timbers. They should be notched till they fit securely against the stringers.

Box culverts should be of seasoned white oak (*Quercus alba*) or creosoted pine, and should be not less than 8 by 12 inches inside, thus requiring the use of four 2 by 12s. A stronger box will be the result if the top, or floor, plank is nailed to the upper edges of the side planks. It is also advisable, especially when a poor grade of lumber must be used, to cut in at least two 2 x 4s crosswise of the box and under those portions of the floor plank which will be subjected to the greatest pressure. Set edgewise under the floor, these will reduce the net inside dimensions to 8 by 8 inches, but this size will be found sufficiently large to carry any ordinary amount of drainage. If an unusually large amount of drainage is to be carried, then six 2 by 12s should be used and a box 12 by 20 inches made. Such a culvert, of course, requires crosspieces under the floor planks, but in a box, say 6 feet long, three 2 by 4s laid flatwise will be of sufficient strength to support all ordinary traffic.

Laid in this manner, the crosspieces reduce the net inside dimensions to 10 by 20 instead of only 8 by 20 inches.

Hollow log culverts of sycamore or buttonwood (*Platanus occidentalis*) and black gum or tupelo (*Nyssa sylvatica*) are widely used in the South and Southeast, being placed not only in trails but in many of the country roads as well. The material is quite durable, and such culverts often remain in good repair for ten or fifteen years or more. However, this timber is not available in most parts of the West.

Corrugated iron piping, or terra cotta tiling used for culverts, should be at least 8 inches in diameter inside. The most widely used size is only 6 inches, but such pipes clog too easily to prove satisfactory for culverts.

Corduroy.—This is a form of artificial bed provided as a means of crossing bog-holes in a trail, and is also one form of construction used in culverts or small bridges of minor importance. Used across bogs, it consists merely of numerous small logs or large poles laid crosswise of the trail and capped usually with dirt or gravel. For deep bogs it may be made more substantial by first placing heavy logs, even 12 or 16 inches in

diameter, at the bottom, lighter logs being laid at right angles across these. If necessary a third tier is placed at right angles across the second.

Frequently only two or three stringer logs will be found necessary for the foundation, corduroy being placed on these to serve as a bed. Ordinarily, if capping is to be from 4 to 8 inches thick, no other fastenings will be required to hold the corduroy in place. If necessary, however, it may be pinned to the stringers with wooden pins or toe-nailed with 60-D spikes.

Drain Ditches.—Ditches of adequate size to prevent the tread being flooded should be provided at all points along important trails where flooding is likely to occur. They may be cut into the bank above or into the ground alongside the trail, or, in case only a limited amount of drainage is to be carried, may be cut directly against the upper side of the trail.

If drainage is to be conveyed across the trail, side ditches should be continued to points suitable as locations for culverts or water bars, the latter being merely logs of sufficient length and size to direct the flow across the trail after they have been set into the ground diagonally to the line of travel.

Proper drainage is absolutely essential to economical maintenance of a trail, and carelessness in construction in this respect may later prove responsible for complete abandonment of the trail. Continued travel tends to settle and otherwise displace the capping material until, if proper drainage facilities have not been provided, water flows directly down the middle of the tread and soon cuts an impassable ditch.[1]

Tread.—The tread of a trail is that portion of it which is exposed to travel, and upon its width depends the greater portion of the cost of construction and maintenance. Its proper consideration in the preliminary survey is, therefore, of the greatest importance and must be given close attention.

In any trail, regardless of its classification, per cent of grade, or any other particularly important characteristic, costs in construction and maintenance will be materially reduced if the

[1] In all parts of the country, and especially in the rural districts or in sparsely settled regions, will be found roads and trails which have been "set over" time after time as each new route has been allowed to wash out and become impassable, the final result being a series of parallel ditches none of which can be used as a path of travel.

width of the tread is kept at a minimum, this point in construction applying with equal force to trails in classes A, B, and C.

Quite naturally it would seem to the inexperienced trail-builder that a class A trail, which might have a uniform grade as low as 6 per cent, and which eventually might be reconstructed into an unusually good wagon road, should have an extra wide tread. The mere fact, however, that it has the low grade is sufficient justification for a narrow tread, because the disadvantages of a narrow tread are offset by the low grade; and as for being rebuilt as a road, he should remember that the way is a trail first and may possibly be a road later.

The maximum tread seldom need exceed 3 feet, and except in short switchbacks can usually be much less. The minimum for trails of little importance should be about 15 inches.

Capping.—This term refers to the material used on the surface of a trail or road and is known in many localities as the "crown," "top," or "top dressing." It should be hard and compact, free from large stones, and of a nature that prevents its ready removal by traffic.

For instance: Very dry adobe forms a fine dust which may be kicked or blown from the trail in large quantities. When thoroughly wet it forms a stiff mud, through which progress can be made only with the greatest difficulty, and holes or ruts made by pack- or saddle-animals do not fill in but remain as such, and after the adobe begins to dry out present a surface even more difficult to travel than one full of large stones. Obviously, such material is unfit for capping. Loam is but little better—as, in fact, are most other loose soils, the yellow clay common to the South and Southeast being especially unsatisfactory in wet weather.

The best capping is of coarse sand or fine gravel, disintegrated granite being exceptionally suitable. Crushed rock, slag, and cinders are also good, and sawdust or rotten wood can be used to good advantage over permanently wet stretches of trail.

Whatever material is used for capping should be thick enough to present a substantial surface for travel and should be graded enough higher in the center than at the sides to allow ample slope for drainage of all rain or snow that may fall upon it.

Blazes.—The standard blaze used by the Forest Service in marking trails is not less than 8 inches long, is cut through the bark into the sapwood, and is accompanied by a horizontal

notch cut directly above it. These blazes are made in trees growing at such points along a trail that at least one blaze is always visible to the traveler as he proceeds in either direction. Ordinarily trees along both sides of a completed trail are blazed both fore and aft; but if limited time for construction renders such blazing impractical, they are often blazed on one side only and in such a manner that in proceeding along the trail in either direction the traveler always observes the blazes to his right. Later, other blazes are made as required.

The foreman or officer in charge of construction should see that large, ragged, unsightly blazes are avoided. Where a trail crosses open country with little or no grading, he should also see that its course is plainly marked either by means of rock monuments or by guide-posts and boards. Intersecting or branch trails should be indicated by guide-boards showing directions and distances to important points. Specifications for such boards will be furnished field men upon application to the proper office.

ROCK DRILLING

Effective rock drilling is possible only when properly sharpened and tempered drills are used. However, volumes might be written on the subjects of sharpening and tempering steel, and still the inexperienced person would not secure sufficiently definite information to justify him in attempting the operations. Therefore, they will not be discussed here. It is suggested, however, that where considerable drilling must be done the field officer in charge of the work should secure the services of a man familiar with the work of sharpening and tempering. Even if such a person demands a higher rate of pay than other members of the crew, his services will prove proportionately more valuable.

Single Jacking.—This method of drilling is employed when shallow holes are to be bored. One man performs both operations of holding and striking the drill and otherwise sees that the hole is properly sunk. A single jack should not weigh more than three and one-half or four pounds.

Double Jacking.—Two men are employed in this work, one holding the drill in position while the other strikes it with a sledge known as a "double jack," and which usually weighs from six to twelve pounds or, in some instances, more. In order to get the best results, either man should be experienced both

in holding and in striking the drill. Such men, however, are not always available, and it may be found necessary on such occasions to teach certain members of the crew how these operations are performed.

The one who is to hold the drill should seat himself in such a manner as to bring the drill between his knees, where, by the use of both hands, he can hold it in the required position. It need not be gripped more tightly than is necessary to hold it in position unless it is of such light material that blows from the double jack produce violent lateral vibrations in it. In such a case a tighter grip is necessary in order to avoid the severe jars which otherwise result to the hands.

Immediately after a blow has been delivered, and while the double jack is being raised for another, the drill should be raised slightly, turned part way around, and then settled back against the bottom of the bore-hole. If it has been unevenly dressed or, instead of being turned on the center, is merely moved at one corner of the bit, a triangular rather than a round hole will be the result, and cutting will be retarded as the result of extra labor imposed upon the striker in cutting the three corners. Ordinarily, such holes are the result of an attempt by the man holding the drill to avoid the labor incident to raising, turning, and settling the drill, but the advantages gained in this respect are more than offset by the striker's extra labor.

By turning the drill after each blow of the double jack the edge of the bit is brought diagonally across the last groove cut and the shoulders of this are chipped away, thus facilitating sinking.

The man holding the drill should keep his hat-brim pulled well down over his eyes, should keep his face turned downward, and should never watch the drill-head. Blows from the double jack may cause this to sliver or splinter, and fragments of steel are often thrown off as if shot from a gun. The striker, however, whose face and hands are above the drill-head, is not subjected to this danger and should watch the drill-head continuously. This permits him to observe any sudden change of the drill's location and to manage the double jack accordingly.

If for any reason the drill sticks or hangs and can not be turned between blows of the double jack, the man holding it should make this fact known to the striker immediately. Meanwhile he should not attempt to loosen the drill by moving or

shaking it about in the bore-hole until he has assured himself that the striker knows he must stop striking. This is usually done with the interjection "Mud!" which all experienced drillers understand to mean that operations are to be temporarily suspended.

Water poured into the bore-hole will not only serve to prevent the drill bit from heating, but will also facilitate cutting. The man holding the drill may protect himself from spattering by placing an old grain sack loosely about the drill at the top of the bore-hole.

Churn Drilling.—This operation is performed by means of a long drill, used, in most cases, by two men and heavy enough to obviate the necessity for using a sledge. It is simply raised and then forced violently against the bottom of the bore-hole, cutting the same as if driven with a sledge. It is especially convenient in drilling into upright faces of rock.

Removing the Cuttings.—Cuttings are removed from the bore-hole with a long, slender tool known as a "spoon." However, if no spoon is available the cuttings may be "swabbed out" by means of a stick, preferably of some hard, tough wood, beaten into splinters at one end. This end is thrust into the cuttings and twisted about till the brush is filled. After removing it from the bore-hole the stick is rapped sharply against the drill or a stone, and is thus relieved of the cuttings.

BLASTING

The construction of permanent improvements, such as roads, trails, and telephone lines, often requires the use of explosives, and unless the new field man has had previous experience in their use he should place a competent man in charge of blasting operations until such time as he himself may have become sufficiently familiar with the work to carry it on with a minimum possibility of accidents.

The two chief forms of explosives used in general field work are dynamite and blasting powder, but since the latter is used less frequently than the former it will not be discussed here. Electric firing of blasts is seldom practised except in ditching through loose dry dirt or gravel and occasionally in controlling severe forest fires. The inexperienced man is seldom required to handle such work, however, and for that reason only cap-

and fuse-firing will be considered. If electric firing must be done, the field man should consult some reliable authority on the subject.[1]

Dynamite.—*Composition.*—This is composed of nitro-glycerin mixed with sawdust, nitrate of soda, and other explosive or absorbent ingredients, and is packed into cylindrical paper shells forming what are known as "sticks" or "cartridges." These are 8 inches long and of different diameters, the standard diameter, however, being 1¼ inches. They are shipped in cases of twenty-five and fifty pounds.

Strength.—The strength of dynamite is expressed in per cent, according to the strength of the explosive regardless of the per cent of nitro-glycerin present, and is known as "20%," "30%," or whatever the strength may be. Straight dynamite is made in strengths from 20% to 60%, gelatin from 35% to 75%, and blasting gelatin 100% only.

Use of Different Strengths.—The required strength of dynamite for different uses may be determined about as follows: For shell rock, hard clay, frozen earth, log splitting, ditching, grading, or other light work, 20%, 25%, 30%, or possibly 40%; for quarry use where stone is to be split but not shattered, 30%, 33%, and 40%; for stumps, tree-felling, ice, and medium hard stone, 40% and 50%; and for extremely hard stone, or iron or steel, 60% straight or 75% gelatin.

Blasting powder, aside from the greater inconvenience encountered in using it, is hardly strong enough in satisfactorily small quantities to produce the desired results when used in the work just mentioned. It may be used to convenience, however, when logs are to be split into comparatively regular sections, such as for cordwood, corral timbers, rails, and posts. Blasting powder for such work should be of FF, FFF, or FFFF granulation.

Caps.—These are small metal tubes closed at one end and designed for the purpose of detonating dynamite. The closed end carries a small quantity of fulminate of mercury, which explodes by ignition, the concussion thus produced detonating the dyna-

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[1] See "The Farmer's Handbook," published by the E. I. du Pont de Nemours Powder Company. Wilmington. Delaware.

See also "Handbook of Mining Details." published by McGraw-Hill Book Company. 239 West 39th St., New York, N. Y.

mite. They are classed as No. 6, No. 7, or No. 8, according to the amount of fulminate of mercury they carry.

Fuse.—This is flexible tape-, cotton-, hemp-, or jute-covered tubing carrying powder used to convey a flame to the fulminate charge in the cap. The different grades are: Plain hemp for very dry work; single tape for damp work; double tape for wet work; and triple-tape or gutta-percha covered for use in water. It comes in double rolls each 50 feet long, one fitting closely inside the other. Ordinarily it burns at the rate of about 2 feet per minute, but if much abraded or if under pressure, as in a tightly tamped bore-hole, the rate of burning will be increased and may even reach 4 feet per minute. It should be stored in a cool, dry place where it will neither become dry and brittle nor have the varnish melted off.

Preparing the Charge.—*Attaching the Cap to the Fuse.*—The required length of fuse, long enough to allow the shot-firer to retire to a safe distance after the fuse has been lighted and before the charge explodes, is cut squarely off from the roll. An inch or two should be cut from the end of the roll first and discarded, as the fuse is constructed of such material that the exposed end always attracts moisture. If in cutting the fuse from the roll the fuse end is flattened it should be rolled round between the thumb and finger, care being taken, however, to see that none of the powder is allowed to escape. This end is then held in a vertical position and the cap is fitted down over it as shown in Fig. 58 until the fulminate charge rests firmly against the end of the fuse. In doing this the cap must not be twisted or rotated about the fuse, as the charge is very sensitive and friction against it may result in an explosion. The final operation is known as "crimping" the cap, and consists in crimping or creasing it about the fuse in such a way that the two are held securely together. The crimp is made near the open end of the cap as shown in the same figure. A specially designed combination crimper, fuse cutter, and punch is manufactured for this purpose and is used as shown in Fig. 59. Many blasters crimp with a piece of hard

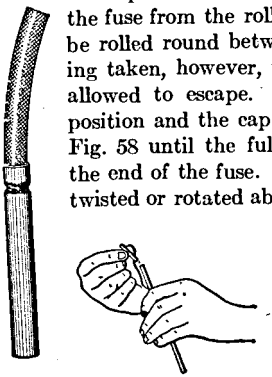
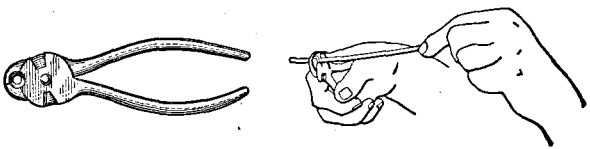


FIG. 58.

sharp-edged wood, with a knife-blade, or with their teeth, but none of these methods should be followed unless a crimper is not



Crimper. Using the crimper.

FIG. 59.

available. In any event crimping with the teeth is a practice to be avoided.

Attaching the Cap to the Cartridge.—Opinions differ as to whether the cap should be inserted at the end or in the side of the cartridge. The latter method, however, is a much safer one by reason of the fact that it not only leaves the entire end of the cartridge exposed for tamping, but also provides a cushion of dynamite between the cap and the end of the tamping stick.

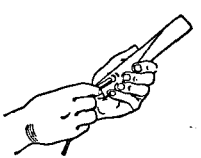


FIG. 60.—Inserting cap in cartridge.

An opening is made in the cartridge by means of the round handle of the crimper, or, if no crimper is available, a smooth round stick of the required diameter may be used. Nails, wire, and small bolts should never be used for this purpose. When the hole has been completed the cap is inserted therein as shown in Fig. 60.

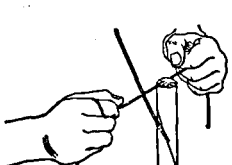


FIG. 61.—Cord about fuse.

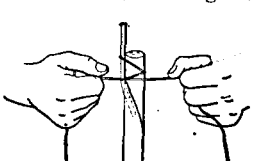


FIG. 62.—Tying the fuse into the cartridge.

A strong heavy thread or light cord is then tied about the fuse as in Fig. 61, and finally the fuse is tied securely to the cartridge as shown in Fig. 62,

If the cap is to be inserted in the end of the cartridge the paper wrapping is unfolded and opened at that end, the hole is punched and the cap inserted, and the wrapping is then closed and securely tied about the fuse.

If the charge is to be placed in water or very wet earth the connection of the fuse and cap with the cartridge should be well covered with grease. This should not be of an oily nature or it may pass through the tape and into the filling of the fuse.

Loading.—This operation, which is also known as "charging," consists in placing the cartridge in the bore-hole or drill-hole. If several cartridges are to be used in the same hole the one bearing the cap, which is known as the "primer," should be placed next to the top or last one and pressed down firmly. The others must also be firmly settled into the hole, and this can be done much more satisfactorily if their wrappers are slit through lengthwise once or twice. This allows them to spread out and fill the hole more closely. Care must be taken to see that each cartridge is pressed firmly against the one before it and that no vacant spaces are left between them.

Another method of loading where only one cartridge is to be used in a hole is to cut the cartridge in half, lower the primed half to the bottom of the hole, press it down firmly, and then tamp the broken-up remaining half in above it. Still another method is to lower the capped fuse into the hole till the cap is at or near the bottom and then tamp the broken-up cartridge about it.

The last method is especially satisfactory where bore-holes are so small that cartridges can not enter readily. They should never be forced into a bore-hole. The chief disadvantage of loading in this manner is the possibility of igniting the dynamite.

Tamping.—Iron tamping rods should never be used when dynamite is to be tamped. The safest method of tamping is by means of a wooden stick cut square at the large end and of a diameter small enough to allow it to enter the bore-hole easily beside the fuse. Fine dry dirt should be used for tamping and should be firmly tamped as filling progresses. The first 5 to 6 inches of dirt should be pressed down firmly but gently. After that greater pressure may be used with little danger, but it should not be greater than that made possible by hand. The hole should be tamped full to the surface. If plenty of grease has been smeared about the connection of the cap and fuse

with the cartridge, water will also make fair tamping, but the charge must be fired before the water can soak into it.

Firing.—In order to save time and facilitate operations the foreman should have other members of his crew remove tools and other equipment to a safe distance while the shot-firer is loading and preparing the charge for firing.

The fuse end should be split back through the center for a distance of ½ inch in order to expose the powder and allow the flame of the match to reach it without delay. Ignition of the powder will be indicated by a sudden hissing spurt of sparks and flame, and the shot-firer should not leave it till this has occurred. He then warns other members of the crew of this fact usually by calling, "Fire in the hole!" and immediately retires to a safe distance. Protection from flying débris should be sought behind large trees or boulders where the bore-hole may be watched and where an unobstructed view of falling earth and stone may be had. Such positions should if possible be selected so the sun and wind will be to the watchers' backs.

Misfires.—These may occur as the result of broken, defective, or improperly prepared fuse, defective caps, or separation of the fuse and cap. They should not be investigated nor worked near for at least an hour after they should have exploded, and if conditions are such that they may be avoided till the next day the safety is so much the greater.

The practice of "picking out" or removing an unexploded cartridge from a bore-hole with intent to reload and fire it is not safe, although in many instances it is more convenient to remove the tamping and reprime than to drill and charge a new hole. If the "missed" hole is shallow enough to permit the charge being seen when it is reached there is little danger of an accident. In such a case a half-cartridge may be primed and loaded in above the first charge, and both may then be exploded.

A wise precaution to observe in loading shallow holes is to tamp a crumpled wad of paper down directly against the charge. If this is done and a misfire occurs the tamping may be picked out of the hole with little danger of picking into the charge.

Holes so deep, however, that such a wad of paper could not be seen should not be picked, but another hole should be drilled at a safe distance and another charge fired. In removing the broken-out material a close watch should be kept for any unexploded dynamite that was placed in the first hole. In most cases

the detonation of the second charge will also result in the explosion of the first.

Blasting Out Boulders.—One of the largest items in the cost of construction of roads and trails is the removal of large boulders from the bed. These are often of such a shape and nature as to prevent their removal by means of teams, bars, or sledges, and they must therefore be broken up with explosives. This involves operations that are not at first sight apparent to the novice, and unless he is careful to adopt the most effective measures he may have little better success than if he had used a sledge.

The first important thing to do in breaking out a boulder is to obtain a general knowledge of its size and shape and the depth to which it may be imbedded. This can be done by shoveling away the dirt at the edges of the boulder or by probing around or under it with a bar. The nature of the ground in which it is imbedded also plays an important part in the work of its removal and must be carefully considered before any charges are placed.

The three chief methods used in breaking out boulders follow:

Mudcapping.—This is also known as "blistering." A dynamite cartridge is stripped of its wrapping and is then pulverized

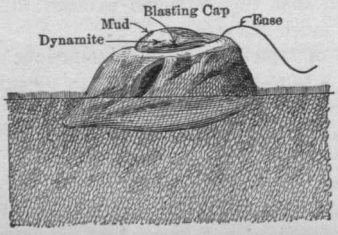


FIG. 63.—Mudcapping.

and laid on top of the boulder in a compact pile. The cap is placed at or near the center of the charge and the whole is then covered with 6 or 8 inches of very damp sand or stiff, wet clay. This is pressed tightly down over the charge and serves as tamping. The method is illustrated in Fig. 63.

Blockholing.—This method of breaking out a boulder is shown in Fig. 64, and is also known as "splitting." Its chief disadvantage lies in the necessity for drilling one or more holes

in the boulder, but this is more than offset by the much more effective results obtained. In order to concentrate the charge as much as possible the cartridge should be broken up and

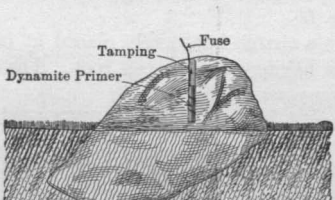


FIG. 64.—Blockholing.

tamped in about the cap. Later, if fragments too large to handle remain, they may be mudcapped.

Snakeholing.—For small boulders that can be easily removed after having been broken from their bed, this method, also known as "gophering," is very effective. The charge should be placed

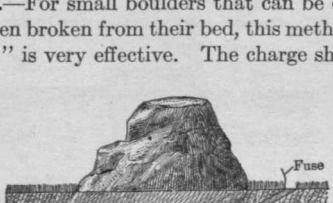


FIG. 65.—Snakeholing.

directly against and at or near the exact center of the under side. It must be well tamped and care must be taken to see that it is not placed at a point where wet or soft dirt may allow the force to be expended downward rather than upward and against the boulder. See Fig. 65. (For Table of Blasting Charges, see page 369, Appendix.)

Blasting Out Trees and Stumps.—The chief trouble in this operation usually lies either in the fact that the charge is placed at the bottom of a hole drilled too straight down and not under

the center of the tree or else it is placed in a hole in such a way that it is carried beyond or to one side of the tap root. For the correct location of a charge expected to affect the tap root directly see Fig. 66.

Fig. 67 shows a charge improperly placed at one side of the center of a tree having no large tap root. The charge should

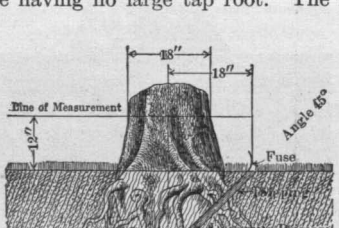


FIG. 66.—Correct location of charge in tap root.

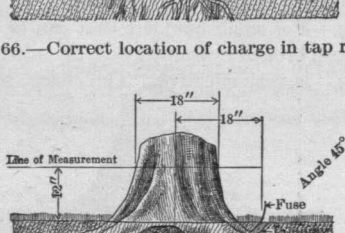


FIG. 67.—Incorrect location of charge in stump having no tap root.

be placed as shown in Fig. 68. Unless it is placed well down under the roots a "blow out" at one side of the tree will be the result. A charge placed too near the surface of the ground is shown in Fig. 69. A similarly placed charge under a stump only serves to split it without removing the roots from the ground. (See Fig. 70.)

If a concentrated charge is desired it may be provided for as shown in Fig. 71, where the lower end of the bore-hole has

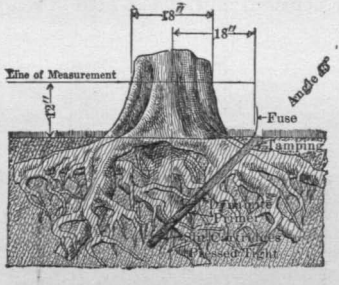


FIG. 68.—Correct location of charge in stump having no tap root.

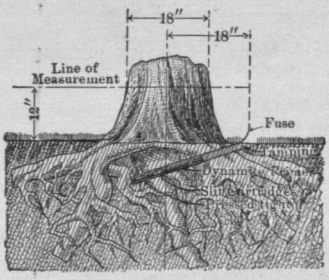


FIG. 69.—Charge placed too near surface.

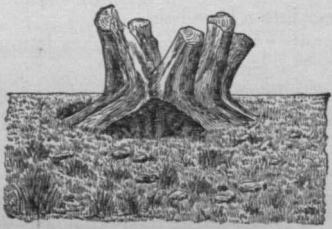


FIG. 70.—Bore-hole too shallow. Stump split, but roots not removed.

been enlarged or " chambered " by exploding a quarter-cartridge in it. Such a chamber should be allowed to cool an hour before the final charge is placed in it, unless fired in wet ground.

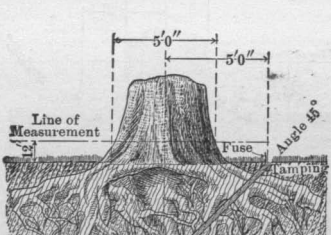


FIG. 71.—"Chambered" or "sprung" bore-hole.

Mistakes to be Avoided.—Allowing priming to be done in or near a magazine.

Allowing stock access to explosives.

Crimping a cap with the teeth.

Cutting a frozen dynamite cartridge.

Cutting fuse too short in an effort to economize.

Disturbing the fulminate charge in a cap.

Drilling or charging a new hole less than 2 feet from a " missed " one.

Exploding a charge before all the workmen have retired to a safe distance or before other explosives have been protected from falling débris.

Forcing a primer into a bore-hole.

Handling dynamite with bare hands unless immune to " dynamite headache." Use gloves.

Immediately reloading a " chambered " bore-hole.

Investigating a misfire in less than an hour after it should have exploded.

Keeping dynamite in a blacksmith shop or near a forge.

Leaving explosives in wet, damp, cold, unlocked places.

" Picking out " a misfire unless the bore-hole is shallow enough to allow the charge to be seen as soon as it is reached.

Removing caps from the box with a nail or wire.

Smoking while preparing or otherwise handling explosives.

Storing explosives in or near a residence.
Storing fuse in a hot, dry place.
Tamping with an iron bar.
Thawing dynamite except in a receptacle especially designed for that purpose.
Transporting or storing caps with dynamite.
Using frozen or chilled dynamite. Most of it freezes at 50° F.

BUILDINGS

Ordinarily, the field man is not required to construct buildings of more elaborate or complicated design than that involved in cabins, barns, sheds, and other buildings of a similar character. Otherwise expert carpenter work is secured and the field man, if he is engaged in the work at all, usually acts as assistant to the carpenter in charge. Consequently, only rudimentary rules of construction will be considered here.

Foundations.—Properly constructed foundations constitute the most important factor in a substantially built house. Stones or blocks comprising foundations should not be set merely on the surface of the earth, but should be firmly bedded on solid rock or earth, and dirt or fine stone then tamped closely about them. This not only provides a much firmer base on which to build, but also prevents water from undermining the blocks or piers. All points of a foundation must be level with each other and secured in such a manner that the process of erection will not displace them. Construction proper should not begin until the foundations have been allowed to settle securely, after which, if necessary, the upper surfaces may be finally leveled. Block foundations, or foundations made of lengths of tree-trunks, can not be recommended for use under any building, whatever its size or use, and especially if it is to be of a permanent nature. The best materials for foundations are concrete, stone, and pressed brick.

Materials.—The materials commonly used in the construction of Forest Service buildings are lumber and logs, although in localities remote from such supplies stone or concrete may be and frequently is used. Corrugated iron roofing may also be used for walls as well as for roofing. As a matter of fact, however, the average field man will seldom find it necessary to use other material than lumber and logs.

Classifications.—Buildings made of the materials mentioned above may be classed as frame, half-frame, box, and log. The first have full frames of studding and joists, are usually built for permanency, and are so constructed as to support great weight in the upper portions.

Half-frames are fitted with fewer studding and joists, may or may not be permanent structures, and will not support as great weight above as full frames.

Box frames have a few or no studding, are ribbed, are more or less temporary in nature, and are seldom more than one story high.

Log frames have neither studding nor ribs, may or may not be built for permanency, and will support heavy upper parts in proportion to the crushing resistance of the wall logs.

Full Frames.—Studding in these are usually spaced at from 18 to 24 inches. Ribs may be fitted into the studding if the walls are to be boxed, but braces may take the place of ribs if regular siding is to be used. Sills may be of solid timbers or they may be constructed by spiking two timbers together in a V-shape or "hog trough" as shown in Fig. 72. Many carpenters insist that the vertical timber of a hog-trough sill should project downward outside of the horizontal timber in order to prevent water from entering the joint, but since this joint is protected, or at least should be protected, by the boxing or siding this point of construction is of minor importance.

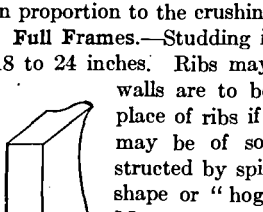


FIG. 72.—"Hog-trough" sill.

Floor joists or "sleepers" are spiked into hog-trough sills as shown at the left in Fig. 73. They are secured to solid sills as shown at the right in the same figure. Studding are fastened to hog-trough sills as shown in Fig. 74, this method being used when the walls are to be boxed. If the walls are to be sided then the studding are notched and set as shown at the right of the same figure. Corner studding for siding are set on the upper surface of the end sleeper, one side and one edge being flush with the outer side of the sleeper and sill, respectively, as shown in Fig. 75. In the same figure is also shown the method used in setting corner studding when the walls are

to be ribbed and boxed. If ribs are to be set into the studding rather than nailed against them, then all studding for box walls are set the same as for siding. Methods of attaching ribs to studding for boxing or for siding are shown in Fig. 76.

To Estimate Lumber for Building.—There are so many styles

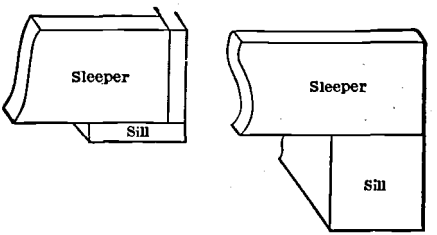


FIG. 73.—Attachment of sleepers.

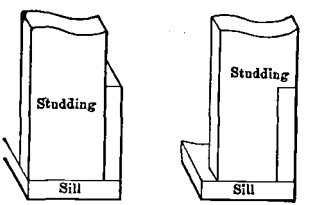


FIG. 74.—Attachment of studding.

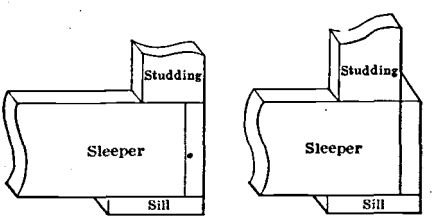


FIG. 75.—Attachment of corner studding.

and varieties of buildings that a comprehensive treatise covering estimates on all would be almost impossible, but a general idea of estimates for the simplest forms of construction may be obtained from the following plan. It is assumed that the field

man is required to estimate the material required for the construction of a cabin 14 by 16 feet in size, with 8-foot walls, rough floor and ceiling, 12-inch eaves and overhangs, no cornice, one rough door, and three shutter windows. The estimate follows:

Sills, Hog-Trough	4	pieces	2 x 6 x 16	64 feet
" Plain	2	"	2 x 6 x 14	28 "
	2	"	2 x 6 x 16	32 "
Sleepers, 2-foot spaces	7	"	2 x 6 x 14	98 "
Ribs	2	"	2 x 4 x 14	20 "
	2	"	2 x 4 x 16	22 "
Plates	2	"	2 x 4 x 16	22 "
Joists, 2-foot spaces	9	"	2 x 4 x 14	85 "
Rafters, 2-foot spaces	18	"	2 x 4 x 12	144 "
Sheeting, 26-inch shakes to be laid 21 inches to the weather, board fashion, twelve courses	14	"	1 x 4 x 18	84 "
Sheeting, shingles to be laid 4 inches to the weather, thirty-four courses	34	"	1 x 4 x 18	204 "
Shakes	1300			
Shingles	4000			
Saddle board, shake roof	none required			
" " shingle roof	2	pieces	1 x 6 x 18	18 "
Floor	14	"	1 x 12 x 16	224 "
Walls	30	"	1 x 12 x 16	480 "
Ceiling	14	"	1 x 12 x 16	224 "
Gables	7	"	1 x 12 x 16	112 "
Nails	6	pounds	20-d	
"	20	"	8-d	
"	9	"	6-d for shakes	
"	7	"	3-d for shingles, 1 nail	
"	15	"	3-d for shingles, 2 nails	

Add one pound of 20s if hog-trough sills are used.

Thirty-five pounds of 8s will be required if three nails are used at each point of contact on the boxing, floor, and ceiling, and also used in nailing on shakes.

Hinges, 4 pairs, 6-inch strap, for door and shutter windows.

Plates, which are those timbers at the top of a wall and upon which the rafters rest, are spiked to the upper ends of the studding as shown in Fig. 77. Eave ribs are attached when boxing is to be used. Studding braces, generally used in walls to be sided, are fitted into the studding in three different ways as shown in Fig. 78. Upper joists, or "stringers," are laid on the plates as in Fig. 79. Rafters are set on the plates, usually

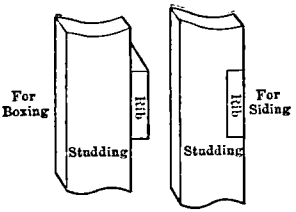


FIG. 76.—Attachment of ribs to studding.

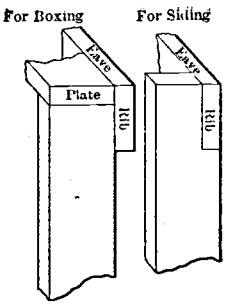


FIG. 77.—Attachment of plates.

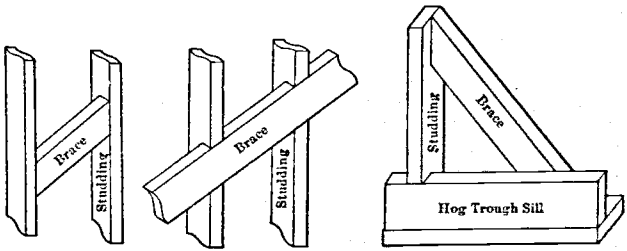


FIG. 78.—Studding braces.

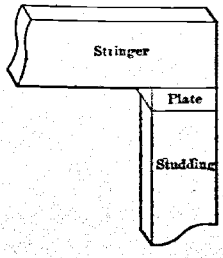


FIG. 79.—Attachment of stringer to plate.

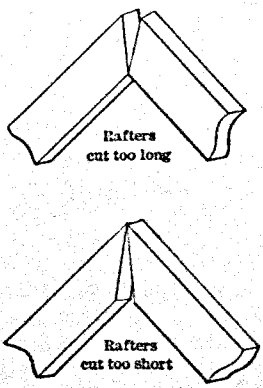


FIG. 80.

against the joists, and spiked to both. If they are cut too long they will not meet at the extreme upper points but will gap as shown in Fig. 80. If cut too short the gap will appear at the under side. They may be tied with "wind" beams or "wind collars" or "collar beams" as shown in Fig. 81. Fig. 82 shows a self-supporting roof. This method of construction prevents

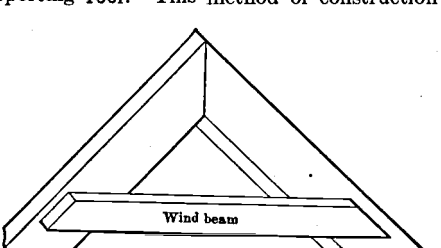


FIG. 81

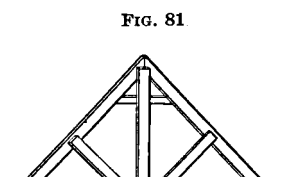


FIG. 82.—Self-supporting roof.

the rafters from sagging and makes a very strong roof. It is frequently used in roofs having long rafters and is very effective where a large amount of snow may remain on a roof for a considerable period. It is not a satisfactory form of roof for barns the upper parts of which are to be filled with hay or other feed. A self-supporting shed roof may be constructed as shown in Fig. 83.

This is known as a "truss" roof. Its chief disadvantage is the extra cost of material and labor required in its construction. Furthermore, the presence of the lower truss beam causes the loss of more or less space beneath the roof.

Half-frames.—This method of construction is similar to that used in erecting frame buildings, the only difference being in

the number of studding and other frame timbers used. Such frames are used chiefly where the walls are to be boxed.

Box Frames.—These have either no studding at all, or at the most only a few. Like the half-frames they are used where

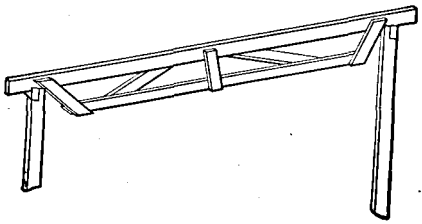


FIG. 83.—Truss roof.

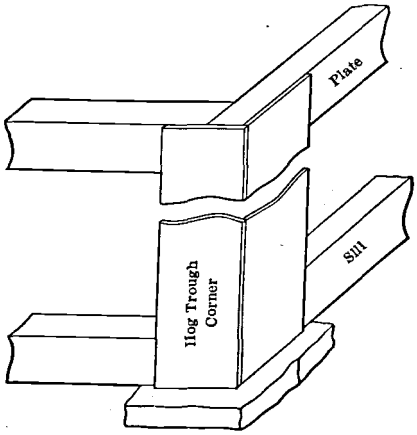


FIG. 84.—"Hog-trough" corner.

little or no pressure will be brought to bear on the plates. Ribs are used occasionally, but these are supported by and serve to increase the rigidity of the boxing. The four hog-trough corners are first set up as shown in Fig. 84 and boxing is then nailed to the sills and plates. Ribs may be put in as soon as the

corners are erected or they may be supplied after all the boxing has been attached.

Log Frames.—Logs to be used in walls should be notched, preferably as shown in Fig. 85. These notches are made after the sides of the logs have been hewn flat from the ends back to a distance of from 12 to 24 inches. Such hewing brings the logs to the required thickness for the wall and leaves the corners of the building in a finished condition if the entire sides of the logs are to be hewn flat later. Ground logs are not fitted with notch No. 1, but are hewn flat on the under side and fitted with notch No. 2. Notch No. 1 in the next log above fits down over notch No. 2 of the ground log. This process of fitting the logs together is followed on up the wall to the top log. This log, which is known as the "plate" log, has notch No. 1, but is not fitted with notch No. 2. Its entire upper surface is hewn flat and supports the rafters. Many log buildings have the top two or three logs pinned through the corners to each other, but this is seldom necessary if the logs are notched as shown in the illustration.

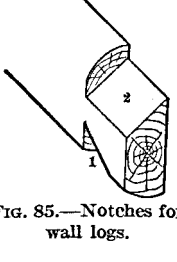


FIG. 85.—Notches for wall logs.

LAYING THE ROOF

Cornice.—This is very commonly though erroneously referred to as the "cornish" or "carnish." In the very roughest forms of construction no cornice is attached, the lookouts and sheeting ends being left uncovered and the openings between, on the plates and rafters, filled with short lengths of board or left open as the builder prefers. A very simple and effective form of cornice and one that completely covers all exposed lookouts and sheeting ends is known as the "box" cornice. It consists of the "facia," which is nailed against the ends of the lookouts and sheeting ends, the "plencia," nailed against the lower edges of the lookouts, and the "frieze," nailed against the walls and close up under the inner edge of the plencia. Ordinarily, the plencia is attached first, the frieze next, and the facia last, although many carpenters prefer to follow other methods of construction. The outer or lower edge of the plencia should come

out flush with the ends of the lookouts and the facia should be cut wide enough to reach from the upper edge of the sheeting to the lower edge of the plencia. A square "box" is recommended for all ordinary buildings, its chief advantage being the fact that it requires less skill in construction than a cornice having a perpendicular facia or a facia set at other than right angles to the plencia.

Sheeting.—The work of laying sheeting begins at the outer face of the cornice where the first sheeting board is nailed out flush with the edge of the facia. As he lays succeeding courses of sheeting the carpenter uses the lower courses as a means of support both for himself and for any extra tools or material that he may need close at hand.

Each course should be nailed to every rafter it crosses and care must be taken to see that joints do not all fall on the same rafter. Unless joints are distributed over the entire set of rafters a weak roof will be the result. The last course, at the apex or the "comb" of the roof, should be nailed securely to the corresponding course on the opposite side. Sheeting for shingles is usually of 1 by 4 lumber laid with 4-inch spaces. Sheeting for shakes that are to be laid "shake fashion" must be spaced wide enough to provide firm support for each end of the shakes. If shakes are to be laid shingle fashion, then of course sheeting is spaced the same as for shingles.

Shingling.—Shingling also begins at the lower edge of the roof. The old practice of cutting shingles for the first course in half in order to avoid a "humped" roof is seldom followed by modern carpenters. This course is simply doubled and full-length shingles are used. In order to keep the lower ends of the first course of shingles even, a shingle is nailed at either end of the roof, a small nail is driven up into the end of each, and a chalk line is then stretched from one to the other. A third shingle should be used at the center of a long roof. When the first course has been laid the end shingles are marked at a point where the lower ends of the next course will reach, the line is well chalked, stretched tightly across the lower course from one end mark to the other, raised, and then allowed to snap down against the shingles, thus leaving a distinct line of chalk against which to set the next course of shingles. These should always cover the joints between shingles in the course below and should be nailed to the sheeting at a point just above where the butts

in the next course above will fall. By nailing them in this manner all nail-heads are hidden and a much neater looking and more durable roof is the result. The last, or top, course of shingles on the side first covered should be sawed off flush with the top sheeting board on the opposite side, while those on the opposite side should be sawed off flush with the upper surfaces of the top course on the first side.

The nails used in fastening the shingles to the sheeting should not be driven so deeply that the heads will split the shingles.[1]

Shingles Required.—The number of shingles required to cover a roof of given size may be obtained by either of two methods, viz.: (1) by ascertaining the number of squares contained in the surface of the roof, including eaves and "overhangs," and multiplying this by the number of shingles required to cover one square; (2) by ascertaining the number of square feet in the roof and multiplying this by the number of shingles required for one square foot. For example: Given a 24-foot roof (plate measure) with 12-foot rafters, 12-inch eaves or lookouts, and 12-inch overhangs, to find the number of shingles required. The two overhangs added to the plate measure make a total roof length of 26 feet, while the 12-inch eave makes the roof, or this particular half of it, 13 feet wide. This makes an area of 338 square feet, or 3.38 squares. The entire roof will of course contain twice this number of square feet. Assuming that the shingles average 4 inches in width and that they are to be laid 4 inches to the weather, it follows that nine shingles are required to cover a square foot or that nine hundred are required for a square. However, carpenters usually estimate that a roof of this sort requires one thousand shingles per square, the extra one hundred shingles being used in the double course at the eave or being discarded as damaged or cull. Very wide shingles do not make a satisfactory roof because of their tendency to swell or shrink and to buckle or split.

Number of Nails for a Shingle Roof.—In all ordinary shingling not more than one nail per shingle is necessary, although many carpenters insist that all shingles, and especially the very wide ones, should be nailed near both edges. However, in single

[1] A common expression among shinglers: "When you lay shingles don't strike the nails a last lick."

nailing, the nail may be driven, for instance, near the left edge of the shingle and far enough above the butt to allow the butt of the shingle in the next course above to cover the nail-head. The other edge of the shingle will be made secure when the next succeeding course is laid, and the shingle will also be further secured by nails which pass through other shingles above. Two nails per shingle will of course make a much more substantial and weatherproof roof. The nails most widely used for sawed shingles are known as " No. 3 Common," and are approximately 1¼ inches long.

Shakes.—This term, typically Southern, applies to clap boards split or hewn from timbers. Ordinarily shakes are made about 4 inches wide and from 18 to 36 inches long, frequently longer if to be used in special construction, such as for walls or for narrow roofs where one course will cover the rafters. They may be laid the same as shingles, but as a general rule are laid in " board fashion," *i. e.*, laid in double courses in such a way as to break joints and at the same time overlap the next lower course by from 2 to 4 inches. When laid in this manner the butts are held even by means of a straight edge tacked to the course below. As each course is finished the straight edge is removed and then tacked to the last course laid. The method of nailing shakes in board fashion differs from that followed in laying them shingle fashion. In the first course a pair of shakes, or " boards," is laid side by side on the sheeting and a third board is laid on top of and parallel with these in such a way that the joint between the lower boards falls immediately beneath it. A nail is then driven through a lower corner of the top board, through the board beneath it and into the sheeting. The nail driven through the opposite corner secures the other board of the pair. The next board is laid beside one of the pair and a second board is placed over the joint and beside the top board first laid, nailing to be done after the manner just described. The upper ends are left unnailed for the time being, but are finally fastened to the sheeting when the next course above is laid. By nailing them in this manner, where nails passing through the course above also pass through the upper ends of the course below, considerable time is saved and the number of nails required is much less than when each board is nailed separately. In view of the extra thickness of most boards, however, it is often found necessary to use much larger

nails than are required for sawed or cut shingles and in very thick or rough boards it may even be necessary to use 8ds. Occasionally, if twisted or warped boards are being laid, it may also be found necessary to use extra nails at the other corners.

Shakes Required.—Estimates for shake roofs, shakes to be laid "shingle fashion," are the same as for shingle roofs. If the shakes are to be laid "board fashion," then a different method of estimating must be followed. Assuming that the shakes are 32 inches long and that they are to be laid 28 inches to the weather, the 13-foot rafters will carry about four and one-half courses, or, as is usually estimated, five whole courses. If the shakes average 4 inches in width. then each course in a 26-foot roof will contain seventy-eight shakes, but since the shakes are to be laid "board fashion" each course must be doubled. This requires one hundred and fifty-six shakes for each of the ten courses necessary to cover the entire roof.

Number of Nails for a Shake Roof.—If shakes are to be laid shingle fashion the same number of nails must be used as for a shingle roof. If they are to be laid board fashion two nails will be required for each shake in the top tier of each course, and in addition thereto an extra row of nails will be required at the comb. The number of nails required for such a roof will therefore be equal to the number of shakes used, plus the extra number required at the comb. Ordinarily 6-penny commons can be used, although it may be found necessary to use 8-penny commons in extra thick or rough shakes.

Saddle Boards.—This completes the roof, and consists of two boards nailed together hog-trough fashion and extending the entire length of the roof along the comb. It provides an inverted V-shaped covering at the comb, and not only serves to hold the last course of shingles more securely, but also prevents the entrance of rain and snow. It should be nailed securely through the shingles and into the sheeting.

A saddle board is seldom used on a shake roof. As a means of protection against snow and rain the last course of boards laid on the side first covered is sawed off flush with the opposite sheeting board, while the last course on the opposite side is not sawed off but is allowed to project upward over the sawed-off ends of the corresponding course on the first side. This is a very common form of roof throughout the South.

LAYING THE FLOOR

Ordinarily the roof is first completed in order to provide shelter for workmen during the completion of a building in bad weather, and after this comes the laying of the floor, which will present an even and substantial surface upon which to work while the door and window casings and other parts are being made and fitted.

Unmatched Flooring.—This is plain, dressed or undressed planks, but if properly laid makes a tight and comparatively even floor. In nailing it to the sleepers the nails must be driven directly through it and into the sleepers, and all nail-heads should be well sunk beneath the surface of the planks if a smooth floor is desired. Crooked planks should be drawn close up against adjoining planks by beginning at one end and nailing to successive sleepers as the planks are forced over. If planks are so crooked or warped that they cannot be forced sidewise, then they may be ripped or planed straight, or, if crooks make even this procedure impractical, they may be sawed half-way through, and thus weakened until they can be bent. Care must be taken in such sawing, however, to see that the point of sawing will fall on a sleeper. Unseasoned flooring should not be used unless battens are placed beneath the joints. At least two nails should be used in each sleeper.

Matched Flooring.—Planks in matched flooring are fitted with a tongue at one edge and with a groove at the other, thus providing for a closed joint between them. The nails used in fastening down the floor should be of a small-headed variety, such as casing nails, and should be driven diagonally through the planks immediately at the rear of the tongue, care being taken not to bruise or batter the shoulder above the tongue. Nailed in this manner the groove of one plank covers the nail-head in the one beside it, and no nail-heads protrude above the surface of the finished floor. No nail is required on the side next to the groove, the tongue of the adjoining plank being sufficiently strong to serve the purpose of a nail.

WALLS

The rules suggested for laying floors apply equally well to walls, except that when boxing is used it is customarily set vertically rather than horizontally, like siding, and battens are nailed

to the outside.[1] Matched or "drop" siding, to be attached horizontally to studding or boxing, bears a tongue at either edge, but these are diagonally opposite each other, thus allowing the lower of one plank to fall outside the upper of the one below. Such a manner of construction presents a shingle effect which prevents the entrance of rain or snow.

Plain siding, or "shiplap," made thicker at one edge than at the other, is laid shingle fashion against the studding or boxing with the thin edge up. Most carpenters allow the lower edge to cover the upper edge of the plank below with a lap of about ½ inch. The work of attaching such siding must of course begin at the bottom of the wall.

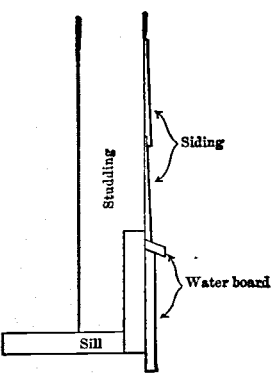


FIG. 86.

Water Board.—This may also be known as a "water shed." It is placed at the bottom of a wall which is to be sided and is nailed directly against the sill. It is designed primarily as a protection to the sill, but also tends to give a building a much neater and more fully completed appearance if a box cornice is used and completed with a frieze. Water boards are seldom used on walls to be boxed. Fig. 86 shows an end view of such a board.

Door and Window Casings and Other Inside Work.—The proper construction and fitting of door and window casings and inside finishing require skill and tools that the average layman does not possess. Therefore, in view of these facts, together with the improbability of a field man being required to do such work, no suggestions on the subject will be offered here. The most practical procedure that can be followed is to secure the services of a professional carpenter who possesses the

[1] Boxing is set horizontally in most tent houses. The reason for this form of construction lies in the fact that set in this manner a minimum of labor and waste of material is secured. Moreover, a tent house is usually only temporary in nature and is seldom designed as a complete protection against extreme weather.

necessary knowledge of and proper tools for finishing such work.

CONCRETE WORK

Concrete.—This form of artificial stone is continually meeting with greater favor among builders, and although the average field man seldom is required to use such material he may nevertheless find occasional need for a knowledge of its general nature. The chief reasons why concrete is in such universal demand are its superior strength as compared with masonry involving the use of lime mortar, the cheapness, ease, and simplicity with which it may be made, the complete success which attends its use in nearly all forms of construction, and the permanency in construction which it affords.

Cement.—This bears the same relation to concrete that ordinary lime mortar bears to other forms of masonry, but differs from lime in its capacity for hardening, or "setting," under water, while lime hardens only when exposed to air. It is obvious that this particular characteristic of cement, which gives it the name of "hydraulic" cement, renders it preferable to lime for general use.

There are a number of different cements manufactured, but Portland and natural cements are most widely used and are the only ones that can be considered in detail here. Rosendale, formerly applying only to the Ulster County, N. Y., natural cements, is a name now given to practically all natural cements of this country. Another variety, known as "Puzzolan," is made by grinding slaked lime and slag together. Silica cement consists of a ground mixture of cement and quartz sand.

Natural Cement.—This is produced by burning certain clay-bearing limestone, or calcareous clay, after it has been quarried and broken in fragments of a size most convenient to handle, the quarrying, breaking, and burning being done in a manner similar to that employed in preparing lime. Later the burned stone is crushed or ground to a fine powder. Natural cement sets quicker than Portland cement, but is considerably inferior in strength.

Portland Cement.—The production of Portland cement consists in grinding the different materials together in desired proportions, after which they are burned, at a temperature higher than that allowed in burning natural cements, and are then

ground again until a fine powder is produced. By reason of the fact that this method of preparation permits absolute control of quantity and quality of ingredients Portland cement is far superior to natural cements, and is therefore more widely used than the latter.

Proportions.—Concrete consists of three principal materials mixed together in water, viz., cement, sand, and aggregate. These are mixed together in proportions previously determined by the nature of the use to which the concrete is to be put, the efficiency of the concrete depending chiefly upon the amount of each material used. The following table of mixtures is in sufficient detail to cover any concrete mixing the field man will be required to do:

Proportions to 1 Part Cement		
Sand	Aggregate	
2	4	For great strength; to resist water.
2½	5	For moderate strength, such as in cellars, walls of small buildings, steps, curbs, etc.
3	6	For ordinary work where a minimum of strength is required, such as in walks, small retaining walls, floors, etc.

Sand.—The three principal varieties of sand are known as "Pit," "River," and "Sea" sand, these names being derived, of course, from the location from which the respective varieties are obtained.

Better results may be obtained in concrete work if coarse- and fine-grained sands are mixed together. Such a mixture reduces the total void, and therefore requires less cement for filling. Any sand used must be screened, if leaves, twigs, dirt, or other foreign materials are present. Voids in sand vary from 25% to 40%, according to the degree of coarseness or fineness.

Pit Sand.—This usually has sharp angular grains and will be found most satisfactory for general use. The chief disadvantage often encountered in securing it is the presence of clay pockets, occasionally so extensive as to make it necessary either

to wash the sand or else mix the clay into it. Clay has no perceptible detrimental effect on rich mortar, and is even desirable in lean mortar when it is thoroughly mixed with the sand.

River Sand.—In nearly all localities river sand has smooth, round grains, made so by constant friction against each other when disturbed by water, and although it is not as desirable as pit sand it may be used with satisfactory results in all ordinary concrete work. As with pit sand, however, care must be taken to see that all foreign material is removed.

Sea Sand.—In addition to the undesirable rounded grains, sea sand may also carry ocean salts, which, unless they are removed by washing, may cause trouble by attracting moisture to concrete which should be kept perfectly dry. Such salts occur, however, in quantities too small to warrant rejection of sea sand when it is needed for other work.

Aggregate.—This constitutes the main body of concrete, the same as brick or stone constitutes the body of other masonry, and is responsible to a corresponding degree for the efficiency of the concrete. Sand, which acts to a certain extent as a filler, is provided chiefly as an aid to proper distribution of and some assistance to the binding quality of cement. The three principal forms of aggregate are: Crushed stone, gravel, and cinders.

Crushed Stone.—This should be angular, sharp-edged fragments of some hard stone, such as granite, trap, gneiss, or quartz, having an average maximum edge length of not more than 3 inches for use in walls or other work from 4 to 6 inches thick. The edge length should not exceed 2 inches for lighter work. Voids vary from 30% to 50%, depending upon the size of the fragments. Crushed stone will prove more generally effective than gravel.

Gravel.—This is inferior to crushed stone in its lack of sharp edges and corners and its softer composition. It should be free from a clay coating and of a size similar to that of crushed stone heretofore mentioned. It does not make as strong concrete as crushed stone, but is nevertheless used extensively and with fairly satisfactory results.

Voids are slightly less than in crushed stone.

Cinders.—This form of aggregate makes much weaker concrete than crushed stone or gravel and is never used except in work where nails are to be driven into the concrete. The cinders must be very hard and care must be taken in ramming not

to crush them. They, therefore, make a thin mixture imperative in order that filling may progress properly with a minimum of ramming.

Water.—Warm water is often used in concrete to prevent it from freezing, and salt water in the proportion of five pounds of salt to one hundred gallons of water is used for a similar purpose when there is no objection to the resultant crystalline deposits which invariably appear during or immediately after setting. However, cold water may be used in freezing weather with no perceptible ill effects on the strength of the concrete.

Re-enforcement.—This is provided as a means of binding concrete so effectively that portions of the concrete can not fall out if cracks or breaks appear. Woven stock wire, barbed wire, mine rails, iron pipe, old wagon tires, or any similar material can be used to good advantage. Re-enforcement material need not be galvanized, as concrete will not rust plain iron. It is especially necessary to re-enforce thin walls, steps, floors, etc., and even in thick, heavy work much more satisfactory results may be obtained if some form of re-enforcement is used.

Mixing.—Thorough mixing and proper proportions of all materials used are absolutely essential in any concrete construction. Dry cement has no binding force. Coarse aggregate used at one time and finer aggregate used at another cause lack of uniformity in strength, or too much of one material or too little of another may so impair the quality of construction as to render the work worthless.

A mechanical mixer is recommended only for use when large quantities of concrete are to be used; otherwise economy demands mixing by hand.

This can best be done by placing proper proportions of sand and cement on a tight-bottomed platform (side and end walls on the platform are unnecessary) and turning the two together with a shovel until the mixture acquires a uniform color. A concavity is then made in the top of the pile and water is poured into this as needed, the mixture of sand and cement being taken gradually from the rim of the crater thus produced. Aggregate, previously wetted down, is then mixed into the "mud," and if necessary more water is added until the concrete is thin enough to pour readily and settle uniformly in the forms. If Portland cement is to be mixed during freezing weather, a minimum of

water should be used or else heated. For table of estimates, see page 362 Appendix.

Forms.—It is always advisable to lay form lumber in water and let it swell to its greatest capacity before it is built into forms; otherwise water from the concrete may soak into and swell it to an extent that will cause it to buckle as it expands and thus present an uneven surface against which to place the concrete.

Forms to be removed and re-erected at frequent intervals should be scraped clean of all large accumulations of concrete after each removal. Except when the nature of the work to be done demands them, sharp corners should be avoided. This may be done by placing a triangular strip in the corner of the form where a corner of the concrete will be exposed. Inside corners require little or no attention in this respect. Nothing definite can be offered on the subject of construction of forms; the work to be done always determines the style of form to be used.

Filling Forms.—If the workman has reason to believe that the nature of the material used for forms is such that the concrete may stick and chip away when the forms are removed he should avoid such trouble by lining the forms with paper each time they are erected. Under ordinary conditions, however, sticking may be prevented by wetting the forms before they are filled.

If concrete is to be dropped more than 4 or 5 feet it should be re-mixed before ramming begins; otherwise the heavier materials may be deposited at the bottom rather than uniformly throughout the mass. Thin mixtures do not require as much ramming as thick ones, and the latter should be thoroughly rammed as filling progresses. Ramming can best be done in narrow walls with a 5-foot length of 1-inch pipe. A heavier implement, preferably a 4- or 5-foot wooden ram having a 4-inch face and shod with iron, will be found more effective for heavier work. Thorough ramming adds about 50% to the strength of concrete and consolidates it from 4% to 6%.

Layers to be built on later should be left rough on the exposed surface and then carefully cleaned and well wetted before the work of filling is resumed.

Setting.—The length of time required for concrete to set depends upon the character and kind of cement used, the amount of water used in mixing, the degree of thoroughness in ramming,

and the temperature of the air. Slow setting will be found preferable to quick setting concrete in practically all ordinary work, and the minimum length of time allowed to elapse before the forms are removed should not in any case be less than forty-eight hours. Even then it is always advisable to protect the work from sudden jars or strains while the new forms are being erected. All concrete grows harder with age.[1]

Cement Finish.—Surfaces to be finished, top-dressed, or plastered with cement should be rough, clean, and well wetted. The plaster, consisting of one part cement to two parts sand, must be thoroughly mixed but with only enough water to leave it plastic. If made too thin it will fail to adhere closely to the concrete. It must be kept well moistened while it hardens. Neat or even very rich cement mortar frequently cracks in setting and is not, therefore, as good for plaster as the mortar carrying the per cent of sand heretofore mentioned. Natural cement plaster should not be used on concrete made with Portland cement nor should Portland cement plaster be used on concrete made with natural cement. Plaster made of equal parts of both may be used on concrete made with the same mixture, but separation of the plaster and concrete frequently occurs when the two are made with different cements. Top dressing on walks, steps, floors, etc., should keep pace with the work of laying the concrete; otherwise the concrete and dressing will not set together

Concrete Blocks.—The method of construction followed in making these, *i.e.*, leaving them hollow, constitutes their chief advantage in many respects. The spaces left in the structures made with blocks reduce the first cost of construction by a corresponding decrease in the amount of material required; they

[1] In recent years numerous prominent architects, builders, and scientists declare that the pyramids of Egypt are of concrete construction, but whether or not such a theory merits serious consideration can not be discussed here. It is a well-established fact, however, that the use of concrete was for centuries practically a lost art, conclusive proof to this effect being provided by the existence at the present time of buildings erected in the Orient in the third and fourth centuries and known definitely to have been constructed of concrete. A prominent architect of Milwaukee, recently returned from a tour of inspection of ancient structures in that locality, states that upon one occasion, when he attempted to chip away fragments of concrete from a bridge, the most vigorous chiseling resulted only in a stream of sparks and failed utterly to chip the concrete.

may serve as passages for flues, wiring, or plumbing, and they prevent sudden changes of temperature within buildings having hollow block walls. Moreover, walls made of hollow blocks may be erected and completed in less time than stone or brick walls and do not require near as much mortar in laying. In strength they are equal to brick walls and in their capacity for resistance to fire are far superior.

Successful block construction, however, requires the use of a block machine, but this expense will prove disproportionate to other expenses unless the proposed structure will require a very large number of blocks. The minimum cost of a reliable machine equipped with enough different moulds for all ordinary work is about $50.00. It will be seen from this that forms of lumber are much cheaper for limited construction.

One of the chief disadvantages of hollow-block walls is their tendency to split when improper proportions are used in the concrete, when careless mixing has been allowed, or when the blocks are laid before they are firmly set. Some medical authorities also contend that residences having hollow-block walls are unsanitary, because such walls attract and retain moisture. In the majority of cases, however, this is due to improper construction.

The general consensus of opinion among builders seems to be in favor of re-enforced solid walls for residences and hollow block walls for other buildings.

PAINTING

Object.—Paint is used for two principal purposes, viz.: (1) To protect iron or wood building material from weathering, and (2) to secure a more pleasing external appearance of buildings and other structures. Used on iron it prevents rust and on wood it prevents the entrance of moisture, which would eventually cause more or less damage through rotting the material.

Composition.—Most paints used in all ordinary outside and inside work consist chiefly of white lead or zinc oxide ground in raw linseed oil and having the coloring matter added to the mixture before it leaves the factory. Body matter invariably settles to the bottom when the paint is left standing for any considerable length of time, and must, therefore, be stirred and forced to mix with the oil before it can be used.

Ready-made paints are usually mixed thicker than is neces-

sary or even desirable, but this trouble may be overcome by adding boiled oil in quantities which reduce the paint to the desired thinness. Thinning with raw oil necessitates the addition of a drier if the work being done requires prompt hardening. Commercial driers are carried in stock by practically all dealers in paint, but if the work is remote from such a source of supply then sulphate of zinc, litharge, or sugar of lead may be used in the proportion of two teaspoonfuls to five pounds of prepared paint of any color. Many painters prefer what is known as "Japan varnish," but if this is used in excess it will cause the paint to crack as it hardens. Turpentine is also frequently used for thinning, except in the first coat. It is cheaper than oil and causes the paint to flow more readily and uniformly from the brush. It may be used in inside work with good results, but reduces the firmness of paint to a degree that renders it unfit for outside work.

In emergencies kerosene (coal oil) may also be used as a thinner, but can be used with better success in stains than in paints. If wax is melted and thoroughly mixed into a stain thinned with coal oil it will produce a smooth, glossy finish.

Colors.—Ready mixed coloring matter may be secured from any paint dealer. Like paint, it should be well stirred before it is added, and finally should be stirred into the paint till the whole mass assumes a uniform color.

Coats.—From three to five coats are applied in all high-grade painting, but in all common work three coats will be found sufficient. Surfaces to be painted must be perfectly clean and dry, and if of lumber, must be thoroughly seasoned. The first coat, known as the "primer" or "priming," should not carry too much oil or turpentine, since these may sink into woodwork and leave a large per cent of the paint body unevenly distributed over the surface, where it will eventually peel away. Very thin paint will not "stand," or adhere well, if used on an iron surface. The second coat should not be applied before the primer is thoroughly hardened. The last coat, in which the coloring matter is placed, may be finished "dull" or in "gloss." Dull or dead finish results from the use of turpentine alone as a thinner; a gloss finish may be secured by using equal parts of oil and turpentine for thinning. Two coats are usually sufficient on iron surfaces, but the paint used in this work should have a body composed of one of the oxids of iron, since white lead, in

common use in paint for woodwork, will not stand on iron and must therefore be renewed at frequent intervals. The red paint known to laymen as "railroad" paint can be used with equally good results on either wood or iron. It carries a large per cent of drier, is cheap and quite generally effective.

Amount of Paint Required for One Square.—For primer work more paint per square is of course necessary than for succeeding coats, this being due to the fact that the open pores of the surface to be painted must be filled before an even surface of paint can be obtained. Usually, on dressed lumber, from five to six pounds of thin keg paint per square will be found sufficient for the primer. If the lumber is undressed and very rough then this amount must be increased even as much occasionally as 50% or 75%.

After a firm primer has been secured the first coat will require approximately four pounds of keg paint per square, while the second and succeeding courses should not require more than two and one-half or three pounds.

Care of Paint Brushes.—These should be thoroughly cleaned and dried after using and before they are stored away. Cleaning can best be done by alternate soaking in coal oil, turpentine, gasoline, or linseed oil and pressing or kneading to remove paint. When free from all paint the bristles may be worked dry with paper or cloth. If the paint is not to be removed, then the brushes should be stored in oil to prevent hardening.

Brushes having the bristles set in rubber or cement should never be boiled: boiling will dissolve the binding and the bristles will be released.

FENCES

On some of the National Forests, especially in the West, where corrals and drift fences must be provided for the proper handling of stock, the field man may find it necessary to devote a large portion of his time to the inspection, repair, or even construction of fences.

These may be of stone, logs, rails, brush, plank, wire, or pickets, depending upon the supply of material available and the permanent or temporary nature of the fence to be built. Plank and wire are the most widely used materials, and fences constructed of these will be found in all parts of the country.

Stone.—A very important item in the construction of a stone

fence, or "wall," is the substantiality of the side walls. If these are to be 4 or 5 feet high the base of the wall should be at least 3 feet thick. Side walls are built up separately with the larger stones at the bottom and are drawn in toward each other as the top is reached, until at the very top the fence has about the same thickness as one side wall. The space between the side walls is kept filled with smaller stones, filling keeping pace with the growth of the walls. Tie stones are used after the side walls have been brought together. A cross section of a stone fence is shown in Fig. 87.

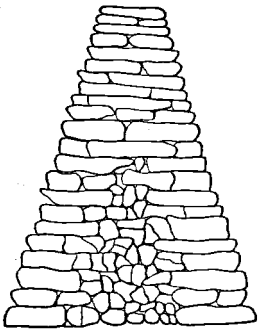
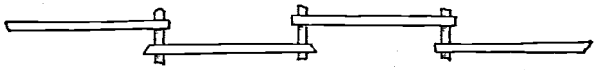


FIG. 87.—Cross-section of a stone fence.

Logs.—Log fences may be constructed as shown in Fig. 88. The short cross logs need not exceed 4 feet in length, and are fitted with notches into which the long logs are sunk. These are also notched on the upper side immediately over the cross logs and the next cross logs above are dropped into the notches. Proper construction of log fences requires them to be built up



Log fence.

FIG. 88.—Method of laying ground logs.

perpendicularly in order to prevent the logs from slipping. This method of construction is especially necessary along steep hillsides.

Rails.—There are two principal methods of constructing rail fences, although a third method is the same as that employed in building log fences. The most widely used style of rail fence, and one that is common to all parts of the South and to many parts of the West and middle West, is known as the "worm" fence, and derives its name from the manner in which the rails are laid. The first rails, or the "ground" rails, are laid as

shown in Fig. 89. Succeeding tiers must be placed firmly on these and the corners or "locks" must be built up exactly per-

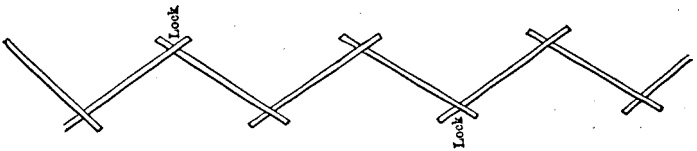
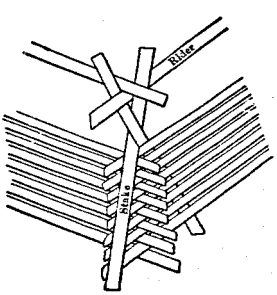
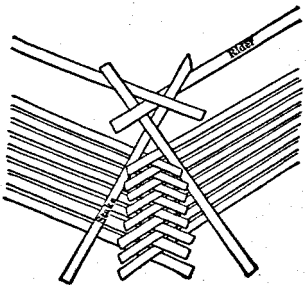


FIG. 89.—Worm rail fence. Method of laying ground rails.

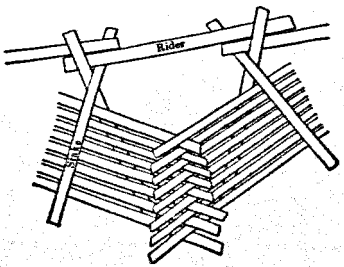
pendicular. The latter may be fastened by means of "stake" rails set as shown in Fig. 90, and these are then held in place by the "riders." Such a fence is known as a "staked and ridered worm" fence. The method of "cross" staking the



Cross stakes at a lock.



Side stakes at a lock.



Panel stakes.

FIG. 90.

locks is shown at the top of the figure. Its chief disadvantage lies in the fact that the stake rails take up considerable ground along either side of the fence. However, the method is about the most common one used.

The second method shown, where the crosses of the stake rails are at right angles to the line of fence, is also widely used. A variation of this method requires the foot of either stake to be set close against the ground rail at the next lock.

A third method of staking is also shown in this figure and provides for the staking of each panel at or near its center. Heavy poles, sometimes long enough to cover six or eight panels, may be used for riders.

Worm fences for corrals should not have short sharp corners. These present excellent opportunities for viciously inclined animals to "hem" or "corner" the weaker ones and punish them severely.

A second general style of rail fence, known as a "post and rail" fence, is illustrated in Fig. 91. Such fences may be built of long poles, and are therefore especially adapted for corrals

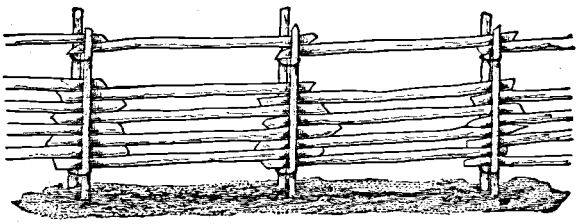


FIG. 91.—Post and rail fence.

and other small enclosures where stock is to be confined for short periods. Posts are set in pairs at desired intervals and are wired or otherwise fastened together, once at or near the ground and again near the tops. A third tie at or near the middle of the posts may also be used if the fence is to be 8 or 10 feet high. This prevents the posts from spreading and allowing displacement of the rails or poles. Where long, heavy poles are to be used and it is not considered necessary to start the fence at the ground, blocks may be cut the desired length and set endwise under the ends of the lower poles. Top poles

may be laid on the top ties, thus serving to bind the posts together more securely. Corral fences of this kind should have rounded corners.

Pickets.—These are known in many localities as "palings," although the latter term is generally applied to the split variety of pickets which are so widely used in fences in the South and Southeast. The construction of a picket fence consists merely in setting the posts at required intervals, connecting them with "stringers," usually two in number, and nailing the pickets to the stringers. The pickets should be set perpendicularly rather than at right angles to the stringers, this rule of construction holding good even when the fence ascends or descends steep slopes. The common idea that more pickets are required in fencing through hilly country than across level country is erroneous, as may be seen by observing Fig. 92.

In this figure it is assumed that the pickets are set perpendicularly. The line 1 indicates a length of fence built across a hill,

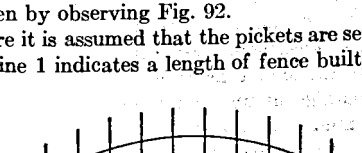


FIG. 92.

while line 2 represents the horizontal length. More posts will be required in line 1 than in line 2 if the stringer lengths are to be the same, and in any case the amount of stringer material must be increased, but the number of pickets will be the same in both lines.

Split pickets, or palings, which are usually too thick and irregular to be nailed to stringers, may be fastened upright by means of wires attached to the posts and woven about the palings as indicated in Fig. 93. The wires are stapled securely to the first post but loosely to the second until the panel has been filled with palings. They are then drawn as tight as possible and securely stapled to the next post. Succeeding panels are constructed in a similar manner. Not less than No. 12 gauge wire should be used, and No. 9 will be found much better.

Plank.—The construction of a plank fence is so simple that little need be said on the subject. If care is taken to trim or set the posts in such a way that a flat surface is presented to the planks,

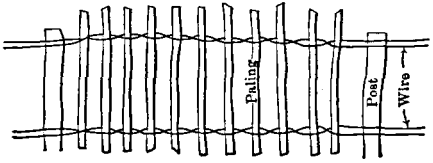
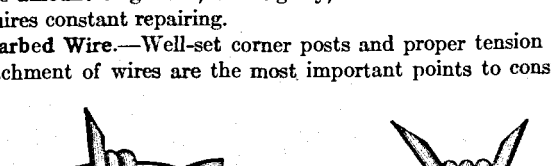


FIG. 93.—Picket or "paling" fence.

and if the latter are sound and securely nailed to the posts, a substantial fence will be the result. Red oak (*Quercus rubra*), Spanish oak (*Q. digitata*), blackjack (*Q. marilandica*), and sycamore (*Platanus occidentalis*) are especially liable to warp, crack, twist, or split and should never be used in a plank fence. The chief disadvantage of any plank fence is its susceptibility to fire and to climatic conditions.

Brush.—A brush fence consists merely of a row of brush piled high enough to prevent stock from passing over it. It is the very poorest form of a fence and should never be used if other material is available. It is very susceptible to fire, takes up a large amount of ground, is unsightly, soon rots and settles and requires constant repairing.

Barbed Wire.—Well-set corner posts and proper tension and attachment of wires are the most important points to consider



2-point or "cattle" wire. 4-point or "hog" wire.

FIG. 94.

in building barbed wire fence. After the fence row has been brushed out and the posts set the lower wire should be laid first, since trouble will be had in separating them if all the wires are laid at once. The common practice of carrying the

spool or reel of wire along the fence row is to be avoided if this is at all possible. It is not only tedious work, but it is also a dangerous practice if the wire is not properly wound on the spool. The best method of laying wire is to bore a 2-inch hole through a heavy plank, place the plank flat on the ground, set the spool endwise on it and hold it there by means of a crowbar thrust through the spool and plank into the ground. The wire may then be laid out with a saddle horse, the rider securing the wire to the saddle horn with two or three turns of a 12- or 14-foot rope tied into the wire and holding the loose end of the rope in his hand. When fastened to the horn in this manner the rope may be released instantly if this becomes necessary. The wire itself should never be looped or tied to the horn. The other man remains at the spool and holds the upper end of the crowbar. Friction of the spool against the plank prevents it from revolving too rapidly and little trouble with tangles need be expected. Spools carry from 80 to 110 rods of wire weighing approximately one pound per rod, and such a length of wire may be laid out with an average size animal trained to pull under the saddle. If not so trained, harness must be used.

However, this method of laying wire can be followed only with difficulty if the wire is to be hung to trees growing along the fence line. Hanging it in this manner necessitates cutting and splicing if the wire is to pass on different sides of trees.

Tension of wires crossing hills and hollows should be tested at the highest and lowest points. This should not be done by seizing the wire with the hands, but should be accomplished by means of a heavy pole or crowbar placed across the wire and forced downward or upward. Defective wires, or even sound wires under great tension, may suddenly break, and when this occurs the ends recoil with a spiral twisting motion that may result in serious injuries to the workmen standing near.

Staples should be set with the points in a line diagonally across the grain of the posts. If driven in this manner they are much less likely to split the wood and always hold the wire more securely. One-inch staples should be used in hardwood, 1¼ inch in medium hardwood, and 1½ inch in softwood.

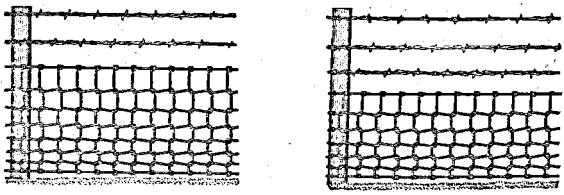
The stretcher must be operated with steady, regular movements and must be so attached to the wire that it will not slip.

The best splice for barbed wire is the same as that used in

splicing telephone wire and which is known as the Western Electric joint. See Fig. 40.

If gloves are to be worn they should be of hard, stiff leather and should fit loosely in order that they may be removed instantly if the barbs hang in them. Soft cloth gloves should never be worn. They not only allow the barbs to injure the hands, but they may become so badly entangled on the barbs that in case the wire breaks or other accidents occur the workman may suffer serious injuries.

Woven Wire.—This is hung with the narrow meshes at the bottom, and, like barbed wire, must be tightly stretched and securely stapled to well-set posts if a substantial fence is desired.



General stock fence. Sheep and hog fence.

FIG. 95.

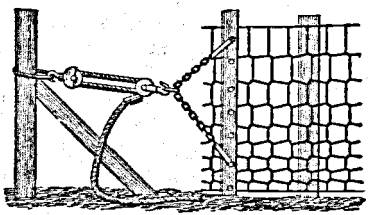


FIG. 96.—Block and tackle stretcher for woven wire fencing.

Its construction prevents it from being laid out from a stationary reel, and the roll or spool must therefore be revolved along the cleared fence row after the loose end has been made fast to some stationary object. The heavy top and bottom wires should be securely stapled to each post, but, except in rare cases, it is not necessary to staple all the intermediate wires so often. The

perpendicular stay wires are not stapled. No trouble will be experienced with buckling line wires stretched across ridges and hollows if the fence is hung so the stay wires set perpendicularly. Splices in woven wire are made the same as in barbed wire, each line wire in one length being spliced to the corresponding wire in the other. Stretchers used on woven wire consist of a pair of heavy wooden clamps which are bolted together through the meshes and which are drawn in by means of a double set of claws working on a chain attached to a tree or heavy post. Another style of stretcher is operated by means of a team hitched to a block and tackle.

Corner Posts.—For ordinary smooth or barbed wire these need be no larger than the line posts, but should be from 12 to 18 inches longer and set deeper in the ground. Woven wire, by reason of the increased strain it imposes on a corner post while stretching is in progress, requires heavier corner posts. They should be not less than 8 inches in top diameter and should be at least 9 feet long. Being of this size they are too large and heavy to be driven with a post maul and must therefore be set. They should either be roofed like a telephone pole or rounded off at the upper end and painted or smeared with tar to prevent the entrance of water.

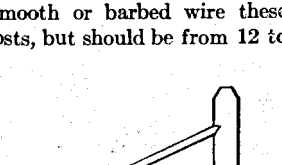


FIG. 97.—Brace for corner post.

Setting and Bracing.—The best method of setting and bracing a corner post is shown in Fig. 97, the same method with lighter material also being effective for corner posts to which smooth or barbed wire is to be hung.

For woven wire the post should be set not less than 3 feet, preferably 4 feet, in the ground, and should be firmly tamped. The brace should be cut long enough to allow the lower end to rest on a flat stone, shown at 1, set at least 12 feet from the foot of the post and directly in line with the fence. The upper end of the brace is fitted into a notch cut about 8 inches below the upper end of the post and is fastened there with a 20-d or 60-d spike, which will prevent its lateral displacement. Six or eight strands of not less than No. 12 gauge smooth or barbed wire are then wrapped about the lower end of the brace and

corner post as shown in the figure and are twisted together with an iron rod or a stick. If a stick is used it should have one end nailed to the brace after the wires have been twisted tight. An iron rod may be driven into the ground.

Line Posts.—The most durable woods for any fence posts are white oak (*Quercus alba*), post oak (*Q. minor*), black locust (*Robinia pseudacacia*), sassafras (*Sassafras sassafras*), red mulberry (*Morus rubra*), any of the cedars or junipers, and dead heart-pine, which carries a large amount of pitch. All posts should be thoroughly seasoned before they are set.

Line posts need not exceed 4 or 5 inches in diameter nor 6½ or 7 feet in length. If they are to be driven, the upper ends should be rounded off to prevent splitting or battering when the maul is used. The points should not be drawn out fine, but should be at least ½ inch across the tip and not less than 16 inches long. Shoulders should be tapering rather than blunt. Posts to be set do not of course require sharpening. The practice of burning or charring the points is not recommended, since posts so treated seem to attract and hold moisture more than when not. For an illustration of a sharpening rack see Fig. 98.

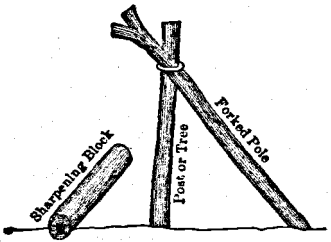


FIG. 98.—Rack for sharpening posts.

Setting or Driving.—Line posts should always be driven rather than set if this is at all practicable. A heavy, sharp-pointed instrument, known throughout the South as a "spud," may be used in starting a hole, or a crowbar may be used for the same purpose. The sharpened post is placed in the hole and is then settled firmly with an iron maul weighing from twelve to twenty pounds. This not only makes a more substantial fence but also eliminates the extra labor that would be required in digging

the holes and afterward tamping the posts, items of labor which involve greater expense than sharpening and driving the posts.

If hard or stony ground prohibits driving, posts may be set into holes, large end downward, and firmly tamped. The holes should not have a greater diameter than is absolutely necessary for removal of the dirt and insertion of the posts. Fine dry dirt should be firmly packed about the posts and a watershed at least 3 inches high should be left above the ground. Mud, or even very damp dirt, does not make satisfactory tamping material. As it dries it will settle away from and allow the post to work loose.

Holes should be from 14 to 20 inches deep. Post spaces for woven wire should not exceed one rod, but in smooth or barbed wire fences where stays are to be used may be as long as 3 or 4 rods.

Lightning Rods.—These are provided as a means of carrying electricity from the wires into the ground. The simplest form is made of ordinary smooth wire, preferably of No. 12 gauge, which is stapled downward along the post, the lower end being placed in permanently moist earth. To insure its contact with such earth the wire should be attached before the post is set. Later it is wrapped closely about each wire in the fence. One such wire should be attached to every fourth or fifth post along fences where stock congregate for water or for protection against extreme weather. Otherwise one wire to every ten posts will be found sufficient.

Gates.—Two very common varieties of fence gates are shown in Fig. 99, one being known as a "sliding" gate and the other

FIG. 99.—Gates.

as a "swinging" gate. Properly constructed and firmly hung swinging gates are preferable to any style of sliding gate, but with the greater first cost of construction the cost of maintenance is also greater. Moreover, owing to a general impression on the part of the traveling public that such gates lock automatically when slammed shut, the danger of their being left open is much greater than that involved in the use of a sliding gate.

Hinges for swinging gates should be so constructed that the gates may swing out of the fence line in either direction, and the style of hinge shown in Fig. 100 is recommended as being the most satisfactory in this respect. Another convenient and durable style of hinge, which may be made from an old wagon tire or from other discarded iron of the same strength, is not fitted with the lag screw which fastens into the post, but consists merely of a heavy staple, into which a bent strap is fitted.

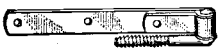


FIG. 100.—Gate hinge.

Any swinging gate should be securely braced from the lower hinge to the corner diagonally opposite, and when possible should also be guyed to the gate post as shown in Fig. 101. Both gate

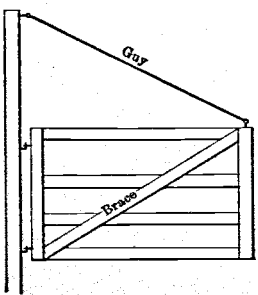


FIG. 101.—Gate guy.

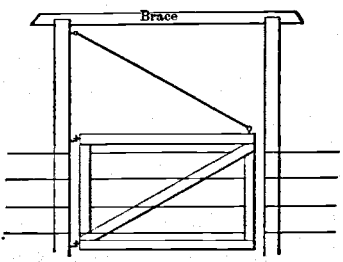


FIG. 102.—Gate tie.

posts in a fence may be tied together as shown in Fig. 102, but care must be taken to see that such ties are high enough to permit the passage of loaded vehicles beneath them.

CARPENTER'S KIT

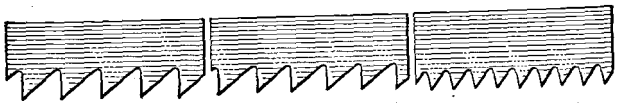
For ordinary rough work about a station a carpenter's kit should include the following tools:

1 Handsaw, cross cut
1 Handsaw, rip
1 Saw, keyhole, or compass
1 Square
1 Brace
13 Bits auger, in 1/16-inch sizes from 4/16- to 1-inch, inclusive
3 Bits, gimlet, 1/8-, 3/16- and 1/4-inch
4 Bits, drill, brace, 1/4-, 5/16-, 3/8- and 7/16-inch
1 Plane, jack
1 Plane, block
4 Chisels, 3/8-, 1/2-, 1- and 1 1/2-inch
1 Level-plumb
1 Caliper
1 Compass
1 Rule, caliper
1 Wrench, monkey
1 Hammer, claw
3 Files, saw, assorted sizes
1 Grindstone
1 Whetstone

Fine work requires a much more elaborate set, but it is assumed that a professional carpenter will be employed when such work is to be done and that he will furnish his own tools. It is obviously impracticable for every field man to have access to a kit even as limited as that listed above, but in most instances he will gradually acquire many such tools for his own personal use. Handsaws, squares, hammers, and grindstones may be secured by requisition, as may also numerous other tools if the nature of the work to be done demands them. At any rate, if he feels that his personal needs demand the purchase of carpenter tools the field man will do well to confine his purchases to such tools as are described below. A complete kit of high-grade tools includes from fifty to one hundred pieces, together with the chest weighs from seventy-five to two hundred pounds and costs from $25.00 to $150.00, or even more.

Handsaws.—*Cross-Cut.*—The two flat surfaces of this are known as the "face" and the "back," the former being the side next the carpenter as he holds the handle of the saw in his right hand, the latter being the opposite side. The end of the cutting edge next the handle is the "heel," the other end the "point." Handsaws are made in various sizes, each of which may be expressed in a different manner by different carpenters. Thus one carpenter may designate a saw as No. 16 because it is made of what is known as "16 spring steel"; another carpenter may refer to the same saw as a No. 11 because it has eleven teeth to the inch. Spring steel numbers are usually indicated on the face along with the manufacturer's name or trade-mark; tooth numbers are stamped on the face near the

heel. Larger numbers of the spring steel indicate greater toughness and flexibility of the blade; larger tooth numbers indicate more teeth per inch and consequently a finer cutting edge. Teeth are frequently known as "points," and a saw may be designated as a "six-point" or "eight-point" saw. A nine-point saw of 12 spring steel will be found most satisfactory for



5½ points to the inch. 6 points to the inch. 9 points to the inch.
FIG. 103.—Handsaw teeth.

general field work, as it may be used with equally good results in hard or soft lumber. It should have a 24- or 26-inch blade with a straight back rather than a skew back.

The straight-back variety may be used as a straight edge in case nothing else longer than a foot-rule is available. The cost is about $1.25 or $1.50.

Filing Handsaws.—A thoroughly practical knowledge of handsaw filing can be acquired only by experience, and the beginner may expect to damage more or less the first few saws he attempts to file. He should bear in mind that unless some teeth have been completely broken out, or at least so badly dulled that the entire set must be filed down, he need not exert severe pressure on his file. Any good sharp file will cut away the teeth faster than he at first realizes, and unless he exercises great caution he is more than likely to find that he has caused himself considerable extra work in the final "jointing up."

The saw should be held firmly in a clamp manufactured especially for this purpose, or, if no such clamp is available, the improvised article may be made from two boards about the length of the saw-blade. These should have their upper outer edges beveled in order to afford the file free access to the saw-teeth. The blade is placed between the boards and the latter are then fastened in a vise. After the blade has been made secure the filer should begin, preferably at the heel of the saw, and file all teeth cutting on one side of the blade before he begins on the others. Assuming that he stands at the vise in such a position that the heel of the upturned blade is to his left, he places his file horizontally across the blade, then moves the file handle

toward his left until the file drops squarely down before the first tooth that cuts on the side opposite him, in this case the back of the saw, and files the forward edge of that tooth. The next tooth on that side is then filed and this operation is repeated on down to the point of the blade. The saw is then reversed in the clamp, or vise, and the remaining teeth are filed in a similar manner. After all the points have been sharpened it then becomes necessary to joint the saw, that is, see that no long or short points are left. Long points cause a saw to jump, hang, feed to one side, or push hard. Short points can not cut, and the only remedy in such a case is to file the other points down even with the short ones. Thus it is that too much emphasis can not be placed on the admonition to be careful and not bear too heavily on the file. Unevenness may be detected by placing the edge of a carpenter's rule along the points.

The whole secret of good saw filing is to keep the teeth as nearly as possible in their original shape.

Setting Handsaws.—Unlike the larger two-man cross-cut saws, most handsaws have such fine teeth and are used in so much finer work that it is next to impossible to set them with anything except a regular saw set. This tool is made in such a way that it can be regulated for different work. Hardwoods require the least set in a saw, seasoned timber requiring not more than $^{1}/_{80}$ inch, or just enough to allow the blade to follow through without binding. Softwoods, by reason of the fact that they cut faster and usually are more or less spongy, require greater set, depending entirely upon their firmness.

Rip.—This should be 26 inches long with a straight back and should have five and one-half or six teeth to the inch. It costs from $1.50 to $2.00.

Keyhole.—This is used in cutting circles or curves and may be known as a "compass" saw. For general use it should have a 12-inch blade. Care must be taken not to kink, crack, or bend it short, since the blade is necessarily very narrow, and therefore easily damaged. The cost, including that of two or three extra blades, varies from twenty-five to forty cents. The uses to which a keyhole saw is put subject it to severe strain that frequently results in a broken or otherwise

FIG. 104.—Keyhole or "compass" saw.

damaged blade, and this of course demands the purchase of new blades. Manufacturers recognize the impracticability of using high-grade steel in such blades, and therefore supply them in lower grades that can be produced at much less expense than better grades used in other saws.

Square.—See pages 127 to 137, inclusive.

Brace.—This should be of the ratchet variety, which permits boring holes in corners or at other points where complete revolutions of the sweep are impossible. It consists of the top or knob or head, the sweep (including the handle), the ratchet, the chucks which hold the bit, and the sleeve which screws down over and forces the chucks against the shoulders of the bit. It should have at least a 10-inch sweep, which makes the crook that carries the handle 5 inches deep. The plain finish is most satisfactory for general station work. The cost varies from $1.50, plain finish, to $5.00, nickel finish.

Bits.—*Auger.*—These consist of the shank, the threads, the knives, the lips, and the screw. The shank is the smooth, round part the squared head of which fits into the chucks of the brace; the threads, or twists, are the spiral wings which remove the borings; the knives cut the borings loose; the lips cut vertically ahead of the knives; and the screw is the threaded lower tip that feeds the knives into the timber. If the screw, knives, and lips are in good condition, no pressure on the brace will be required to make the bit cut.

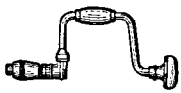
Bits carrying only one thread or wing are known as "solid center" bits, but they may carry two knives and lips. They cost from $1.25 to $2.00, while those with double threads cost from seventy-five cents to $1.00 per set, depending upon the number in the set, usually thirteen. Most manufacturers stamp the size of each bit, either on the shank or on the squared head, the size number being indicated in $^{1}/_{16}$-inch. Thus a bit stamped "14" is known to have a cutting diameter of $^{14}/_{16}$- or $^{7}/_{8}$-inch, while one stamped "5" cuts a $^{5}/_{16}$-inch hole.

Car.—These are for use in boring heavy timbers and may be either single or double threaded. They seldom are equipped with a lip. They vary from $^{5}/_{16}$- to 1¼-inches in diameter and cost from thirty-five to seventy-five cents each.

Expansive.—These have no twist, but are fitted with a movable knife bearing a lip, the screw usually bearing a second lip.

They vary in price from $1.20 to $2.00 each, depending upon the size.

Drill.—These are for use in iron or in hard, close-grained

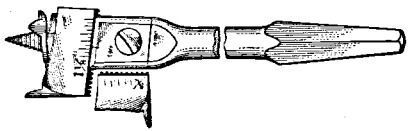


Brace.

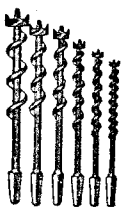
Car bits.

Brace drill.

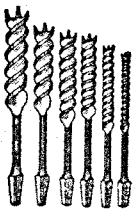
Gimlet bit.



Expansive bit.



Solid center.



Auger.

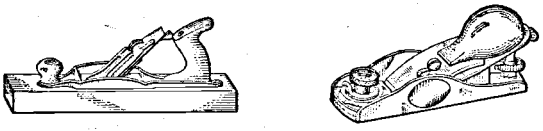
FIG. 105.—Bits.

wood, and are especially adapted to boring timbers that may be full of nails or other metals or in boring holes that must be started near or through iron. Instead of having knives and

lips like auger bits the lower ends of the threads are cut back at an angle of about forty-five degrees or less and are ground flat, the sharp edges thus produced forming the peculiarly constructed knives necessary in boring iron or hardwoods. These bits are made in $^1/_{16}$-inch sizes and cost from ten to thirty-five cents each.

Gimlet.—Gimlet bits are shaped about the same as drill bits, except that the knives are longer in proportion to the rest of the bit and the material of which they are constructed is not as durable as that of drill bits. They are for use in boring small holes through very soft wood and cost from five to ten cents each.

Planes.—*Jack.*—For general use about a station this plane should have an iron frame 15 inches long and wide enough to carry a 2-inch bit. Lateral regulation of the blade or bit is



Jack plane. Block plane.

FIG. 106.

provided for by means of a thumb lever immediately before and at the upper end of the handle. It may be set to cut deep or shallow by revolving a circular milled nut which raises or lowers it through the medium of a flanged tumbler located parallel with the frame beneath the upper part of the blade. The cost is $1.00 or $1.50.

Block.—A block plane is especially adapted for cutting across the grain of wood. The blade is raised or lowered by means of a small horizontal screw wheel located immediately beneath the palm piece. Its rim works in a Y-lever fitted at the forward end with a vertical elbow joint the end of which fits into grooves in the lower side of the blade. To release the blade the screw bolt near its center must be loosened until the blade can be slid along to where the hole at the end of the slot coincides with the bolt. This plane should have about a 6- or 7-inch frame and should carry an inch or an inch-and-a-half blade. The cost varies from seventy-five cents to $1.50.

Chisels.—These consist of the wooden handle, the handle socket, the shank, the blade, and the bit. The last has a single

bevel at the rear and the corners are square. Ordinarily a set includes eight pieces, but for all common work about a station four chisels will be found sufficient. These should be ½-, ¾-,

FIG. 107.—Chisels.

1- and 1¼-inches in size. The four cost from seventy-five cents to $1.50.

Level-Plumb.—In view of the fact that many inferior instruments are placed on the market, this tool should be tested before it is purchased. An easy yet accurate test is to place it on a smooth, straight plank and then block the plank up till the instrument indicates that it is level. This will be when the bubble remains stationary immediately under the mark found on the glass or the glass guard. If the bubble assumes the same position when the instrument is reversed the level is reliable. The plumb is tested in a similar manner except that the instrument is placed in a vertical position against an object known to be plumb. The bubble will rest immediately under

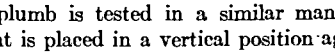


FIG. 108.—Level-plumb.

the plumb mark regardless of whether the face or the back is placed against the object.

The best instrument for rough work has a 20-inch iron frame and costs from seventy-five cents to $1.50.

Caliper.—A caliper is for use in securing diameters, and the best style for all-round work has flat legs that may be pushed past each other so the instrument may be used in securing inside as well as outside diameters. The cost is from ten to twenty-five cents.

Compass.—This is used in laying off circles or curves. It should be of the 8-inch extension variety, which inscribes a

41-inch circle and which costs from seventy-five cents to $1.25.

Caliper Rule.—This should be of the fourfold variety, full brass bound, boxwood, ½-inch wide, spaced in ⅛-, 1/10- and

Caliper.

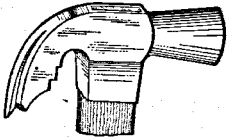
Compass or dividers.

FIG. 109.

1/12-inches with drafting scale. The caliper, which works in the end of one joint, will be found very convenient in ascertaining outside diameters of bolts, pins, etc. The cost is about fifty cents.

Monkey-Wrench.—This tool should be about 10 inches long with a heavy wrought bar and head and a deeply milled screw. It costs forty or fifty cents.

Claw-Hammer.—A square-faced hammer is sufficient for all rough work, but finer work requires a round face that will not bruise the wood if this is struck either intentionally or through



Claw-hammer.

Monkey-wrench.

FIG. 110.

accident. The hammer shown in Fig. 110 may also be used as a wrench, but too great leverage must not be attempted or the handle will be cracked or broken. It weighs about eighteen ounces, including the handle's weight, and costs from fifty cents to $1.00. A claw-hatchet should weigh thirty or thirty-two ounces and can be bought for from forty to seventy-five cents.

Files.—*Saw.*—These should be triangular and 7 inches long. They cost from $1.00 to $1.50 per dozen.

Wood.—A 14-inch half-round rasp will be found very convenient for all rough work and costs from fifty to seventy-five cents.

Grindstone.—This is almost an absolute necessity at every station where edged tools are used and is usually supplied upon requisition if the nature of the work to be done seems to justify such an expenditure. It should have a take-down tubular iron frame fitted with seat and pedals for use by one man. It should also be equipped with ball bearings, water cup, and guard. The stone should be 20 or 22 inches in diameter, of Berea grit and 2 or 2½ inches thick. It weighs about sixty pounds, making the weight of the entire implement approximately eighty-five pounds. The cost is about $5.00.

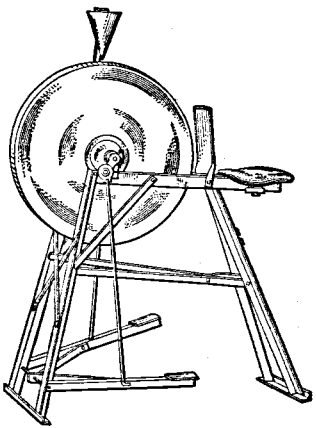


FIG. 111.—Grindstone.

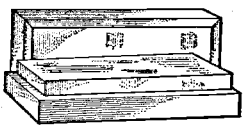


FIG. 112.—Oilstone mounted in block.

Whetstone.—This is to be used in finishing the sharpening of tools and should be of the tough, fine grit known as an oil stone. It should weigh about one pound and should be set in a block fitted with a cover. The cost is about fifty cents.

The Carpenter's Square.—A carpenter's square means no more to a man not versed in its use than an instrument whereby he may lay off straight lines, erect perpendiculars to them, and measure distances in feet and inches. As a matter of fact, these three uses of the square are the simplest to which it can be put. Therefore, in order to assist the beginner in mastering a knowledge of the more important uses of the square a few of these will be explained here. The most reliable style of square for general use is that known as the "No. 100," which costs from $1.50 to $2.00.

Parts.—These are the "blade," or the 2-foot length, 2 inches

wide; the "tongue," or the narrow arm, 14, 16. or 18 inches in length; the "face," or the upper surface of the square as the carpenter holds the blade in his left hand and the tongue in his right; the "back," or the reverse side; and the "heel," or the outer angle formed by the junction of the blade and tongue.

Graduations.—The outer edge of the face of the blade is graduated in $^1/_{16}$-inches, the inner edge in $\frac{1}{8}$-inches, the outer edge of the back in $^1/_{12}$-inches, and the inner edge of the back in $^1/_{32}$-inches.

Graduations on the tongue are the same as on the corresponding parts of the blade except that on some styles of the No. 100 the inner edge of the back of the tongue is graduated in $^1/_{10}$, inches.

Tables and Scales.—The following tables and scales will be found in some form on any No. 100 square and the discussions covering them have reference only to that style of square:

Diagonal Scale.—This scale is a square inch divided diagonally as shown in Fig. 113 and is provided for the determination of $^1/_{100}$-inches. It is found on the face of the square at the junction of the blade and the tongue. Primary divisions are made by intersections of the diagonal with the parallel lines, such intersections being $^1/_{10}$-inch apart on the latter. The diagonal line starting at the lower left-hand corner of the rectangle strikes the upper edge of this figure $^1/_{10}$-inch to the right of the perpendicular left-hand edge of the rectangle. In other words, after crossing the square inch it has departed $^1/_{10}$-inch from the perpendicular. Thus the first interior parallel line from the bottom is crossed at a point equal to one-tenth of one-tenth, or $^1/_{100}$-inch, from the perpendicular line. The sixth parallel line from the bottom is crossed at a point equal to six-tenths of $^1/_{10}$-inch, or $^6/_{100}$-inch from the perpendicular.

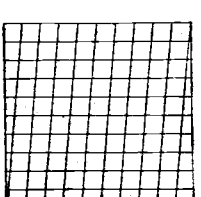


FIG. 113.—Diagonal scale.

Assuming that the carpenter wishes to ascertain a measure of $^{73}/_{100}$-inch, he places one leg of his compass on the intersection of the eighth diagonal line from the left with the third interior parallel line from the bottom, the other leg of the compass being placed on the point where the third parallel line strikes the per-

pendicular left side of the diagram. Thus the compass covers $^{7}/_{10}$-inch plus $^{3}/_{100}$-inch or $^{73}/_{100}$-inch.

$^{1}/_{100}$-*Inch Scale.*—Like the diagonal scale, this scale is provided as a means of ascertaining a measure as small as $^{1}/_{100}$-inch and is found on certain styles of the No. 100. It consists merely of an inch line divided into quarters, these into fifths and these again into fifths, and is found usually at the inner side of the angle on the back of the blade. Owing to the necessarily small fine markings and the possibility of their being obliterated by rust or bruises, this scale is not as satisfactory as the diagonal scale.

Board Scale.—On the back of the blade on some styles of the No. 100 will be found a series of figures which indicate the

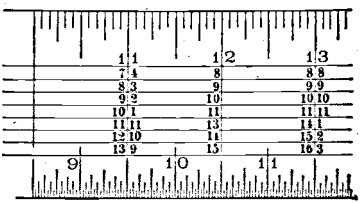


FIG. 114.—Board Scale.

number of board feet contained in a 1-inch plank of given length and width. This table includes lengths of 8, 9, 10, 11, 13, 14, and 15 feet, which are found in the column under the 12-inch measure at the outer edge of the blade. The 12-foot length is omitted because it is evident at once that the contents of any inch plank 12 inches wide are equal to the plank's length in feet. Other inch measures along the same edge of the blade serve as plank widths, the figures in the columns directly beneath them indicating the contents, in board feet, of different-sized planks.

Thus the contents of a plank 6 inches wide and 10 feet long are indicated by the figures found where the 10-foot length line, under 12, crosses the 6-inch width column, under 6, the number of board feet in such a plank being five. If the plank is 2 inches thick, then five must be multiplied by two; if 6 inches thick, then by six, etc.

In view of the fact that a large per cent of lumber is cut 16 feet long, this board scale would be much more convenient if it included a 16-foot length. However, the number of board feet in a plank exceeding 15 feet in length may be secured by doubling the contents of a plank half as long. Thus a 16-foot plank 9 inches wide contains double the number of board feet found in an 8-foot plank of the same width, or twelve board feet.

Rafter Table.—On one style of the No. 100 this table is found along the center of the back of the tongue, the various groups of figures representing the "run" and "rise" and the length of the rafter from the comb to the outer edge of the plate. Thus the group $\frac{60}{60}$ 84.85 indicates a run of 60 feet, or inches, a rise of the same and a rafter length of 84.85 feet, or inches. At first glance it may appear to the inexperienced that since only fourteen groups are given (on most squares) these provide only for fourteen different rafter lengths. However, close observation of the first thirteen groups, reading toward the right from the end of the tongue, will reveal the fact that they are arranged in increasing and finite arithmetical progressions. Two of these progressions represent run and rise, and, being equal, are therefore applicable only to rafters which are to be cut for a half-pitch roof, which, by the way, is the most widely used pitch for roofs. The first term is 24, the constant difference is 3, and the last term is 60. The third progression, composed of the numbers found to the right and midway between the numbers representing run and rise, indicates the length of rafters which are to cover the length of run and rise shown. The first term is 33.95, the constant difference is approximately 4.24 and the last term is 84.85. These numbers may be used to indicate inches, feet, yards, rods, or any other units of length.

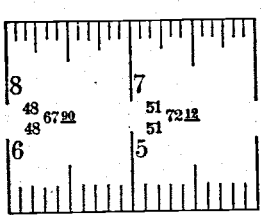


FIG. 115.—Rafter table.

Other lengths than those given may be determined by using this table as a basis of computations and dividing or multiplying a group according to whether the proposed rafter is to be longer or shorter than that indicated in the group. Thus, given a run

and rise of 6 feet, to determine the rafter length: The first group may be used to best advantage; $\frac{24}{6} = 4$; $\frac{33.95}{4} = 8.49$, the length required.

Or, given a run and rise of 90, to find the rafter length: Examination of the various groups shows the eighth to be most convenient; $\frac{90}{45} = 2$; $2 \times 63.64 = 127.28$, the length required. It will be seen from this that instead of covering only thirteen different rafter lengths these thirteen groups cover the subject of rafter lengths for equal run and rise in a very complete manner.

The fourteenth group, $\frac{18}{24}$ 30, applies to other pitches. Assuming 24 as run and 18 as rise, the roof will be ⅜-pitch, and, like the half-pitch, is a favorite among builders. Reversing the relations makes a rise of 24 and a run of 18, or a ⅔-pitch, which is seldom used.

Other rafter lengths covering run and rise of the same relative proportions may be obtained in a manner similar to that employed and previously described in the matter of rafters to be cut for half-pitch roofs.

It is well to remember that the use of this table is not confined exclusively to rafter and brace lengths. It may be applied with equal facility to land measurements and to other work involving hypotenuses.

Pitch Table.—Some styles of the No. 100 bear a table on the back of the blade which shows the pitch of rafters or braces after the run and rise have been determined.

Pitch is determined by dividing the rise by twice the run.

$$\text{Formula: } \frac{R}{2 \text{ Run}} = P.$$

For example: Given a 10-foot rise and a 15-foot run, to determine the pitch. The solution follows: $\frac{10}{2 \times 15} = \frac{1}{3}$ pitch.

Ordinarily 12 is assumed as the run and other numbers as the rise, thus: 12–4, 12–6, 12–8, etc., these combinations appearing in the first double column of the table shown in Fig. 116. Pitch is indicated in the second column as ⅙, ¼, ⅓, etc. Run

may be taken at each inch mark along the outer edge of the blade.

Thus, in a quarter-pitch roof having a run of 4 feet, the rafter length is found in the quarter-pitch line under 4, and is 4 feet, 5⅝12 inches. In a half-pitch roof (in which the run and rise are always equal) if the run is 3 feet, then the rafter length appears in the half-pitch line under 3, and is 4 feet, 2¹½12 inches. No provision is made for lookout lengths.

Rise for different pitches may be determined by simple operations in proportion. For example: In a sixth-pitch roof the

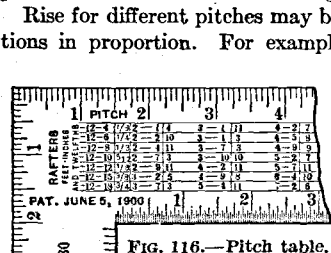


FIG. 116.—Pitch table.

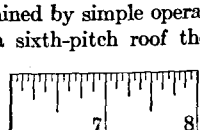


FIG. 117.—Octagon rule.

rise must be to the run as 4 is to 12 (first line). In a third-pitch roof it must be to the run as 8 is to 12 (third line).

Octagon Rule.—This is found along the center of the face of the tongue and is supplied as a means for laying off gauge-lines on a square timber that is to be dressed down to an octagon. Assuming that such a timber is 12 inches square, lines are drawn across the ends of the timber exactly through the center and at right angles to each other, so that each end is marked off into four 6-inch squares. The carpenter then sets off on either side of each center line, where it strikes the edge of the timber, a number of spaces on the octagon rule equal to the timber's width in inches, in this case 12. The points thus determined indicate the proper place from which to stretch the chalk- or gauge-line. If the timber is 16 inches square then sixteen spaces of the octagon rule are used.

Other Uses.—*To Lay off Rafters.*—Assuming that a run is 12 feet and a rise 8 feet and that the rafter length has been determined, let the 12-inch mark on the back of the blade represent the run and the 8-inch mark on the tongue the rise. As the carpenter stands on the proposed long side of the rafter holding the blade in his left hand and the tongue in his right, he

places the 12-inch mark at the point decided upon for the long side or upper edge of the rafter foot. The 8-inch mark is then placed directly over the long edge of the timber and the latter is marked along the edge of the blade, this line indicating the proper angle at which the foot is to be cut. In laying off the upper angle the 8-inch mark is placed immediately over the point decided upon as the upper end of the rafter. The 12-inch mark on the blade is then brought out flush with the upper edge of the rafter and the timber is marked along the edge of the tongue. This mark indicates the angle at which the upper end of the rafter is to be cut.

A second method of laying off rafters and at the same time marking their length follows: Assuming that the run is 12 feet and the rise 8 feet, place the square on the timber so the 12-inch mark on the blade and the 8-inch mark on the tongue fall di-

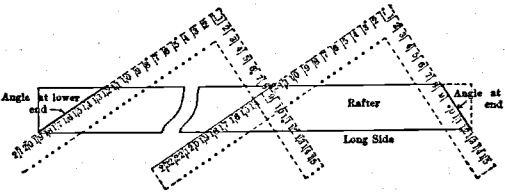


FIG. 118.—Method of applying square in obtaining length of rafter.

rectly over the proposed long side of the rafter. A mark along the edge of the blade indicates where the timber must be cut to form the rafter foot. The 12-inch mark is then moved along the timber to where the 8-inch mark first rested, and this operation is repeated as often as is necessary in running the length of the rafter, in this case twelve times. A mark made along the edge of the tongue at the last application of the square to the timber will indicate the angle at which the upper end of the rafter is to be cut. The work of laying off the rafter length in this particular case may be shortened by using the figures 24 and 16 on the blade and tongue, respectively, thus requiring only six applications of the square to the timber. The one rule to remember in laying off rafters in this manner is to find first how many times the distance used as run on the square is contained in the total run of the roof, and then to apply the square this number of times to the timber. It is hardly necessary

to say that if the figures at first determined upon as representing run and rise on the square are later changed, they must be kept relatively the same as the originals.

To Lay Off a Lookout.—This is merely an extension of the rafter and is intended to project over and protect the plate.

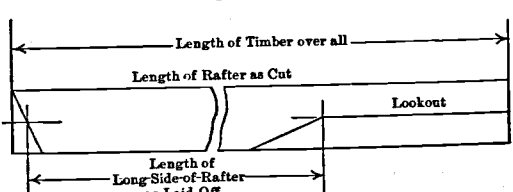


FIG. 119.—To cut rafter lookouts.

The rafter should be cut the same as any other except that instead of cutting clear through the timber it is cut from the under side only to the intersection of the lines marking the angle and the under side of the lookout. Thus, if the lookout is to be 2 inches thick the angle should be drawn from a point exactly 2 inches in from the long edge. Likewise, the point which marks the upper end of the rafter must be set in 2 inches from the long edge and the angle drawn through it. (See Fig. 119.)

To Lay Off Stair Strings.—The run, or the horizontal distance from the foot to a point directly beneath the head of the stairs,

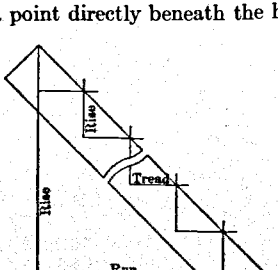


FIG. 120.—Stair string.

is first obtained. (See Fig. 120.) After the rise of each step has been decided upon, the number of steps required for the entire string is obtained by dividing the total rise by the rise

of one step. Tread of each step is obtained by dividing the run of the string by the number of steps. The square is used the same as in laying off rafters or braces.

To Lay Off Octagons When No Octagon Rule Is Available.—Lay the square on the face of the timber, as shown in Fig. 121, with the heel flush with one edge of the face and the outer corner of the

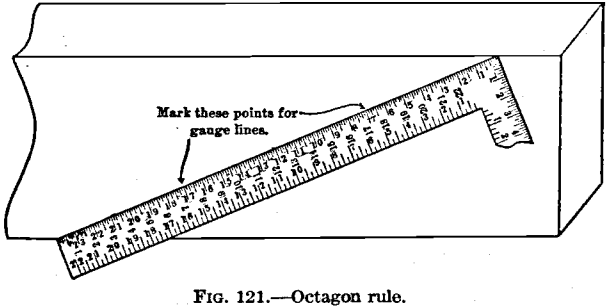


FIG. 121.—Octagon rule.

blade flush with the opposite edge. Mark the timber where the figures 7 and 17 fall and repeat this operation at the other end of the timber. Gauge-lines drawn between respective points thus marked near the ends of the timber will indicate the depth to which the timber must be dressed, the rule holding good on any size timber and being sufficiently accurate for any rough work. A 2-foot rule may be used in a similar manner if no square is available.

To Obtain the Center of a Circle.—Apply the square to the circle

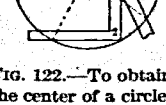
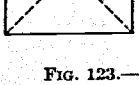


FIG. 122.—To obtain the center of a circle.



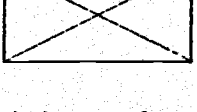


FIG. 123.—To obtain the center of a rectangle.

twice as shown in Fig. 122. The circumference is marked where the blade and tongue cross it and the pairs of marks are then connected as shown in the figure. The intersection of the con-

necting lines indicates the center. Care must be taken to see that the figures used are the same in both applications of the square to the circle.

To Obtain the Center of a Rectangle.—Draw connecting lines between diagonally opposite corners as shown in Fig. 123. The point of intersection between the two lines indicates the center of the rectangle.

To Erect a Perpendicular without a Square.—It not infrequently happens that an odd job of carpenter work about a station requires the erection of a perpendicular when no square is available. This may be done by means of a compass or a string and pencil as shown in Fig. 124, wherein the point 3 indicates the place at which the perpendicular is to be erected.

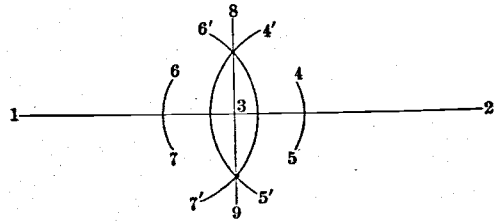


FIG. 124.—To erect a perpendicular without a square.

With 3 as a center the arcs 4–5 and 6–7 are laid off, being, of course, arcs of the same circle. Their points of intersection with the line 1–2 are used as centers from which to lay off 4′–5′ and 6′–7′. The line 8–9 drawn through the points of intersection of these two arcs is perpendicular to the line 1–2.

To Bisect an Angle without a Square.—If this must be done and no square is at hand, the compass or string and pencil must be used again. Assuming that the angle 2 in Fig. 125 is to be bisected, it is used as a center from which to lay off the arc 4–5, and the points of intersection of this arc with the lines 1–2 and 3–2 are used as centers from which to lay off arcs 8–9 and 6–7. The line 2–10, passing through the intersection of arcs 6–7 and 8–9, bisects the angle 2.

Improvised Square.—A very satisfactory substitute for a square is illustrated in Fig. 126. Its construction, however, calls for the use of a foot-rule, yardstick, or other similar instru-

ment whereby lengths may be laid off. Unless such an instrument is available it will be almost impossible to fasten the two parts together exactly at right angles to each other, and if the substitute is to be reliable it is very necessary that this point of construction be carefully observed.

The principle involved in securing perfect right angles between the two parts is based on the well-known 47th problem of Euclid.

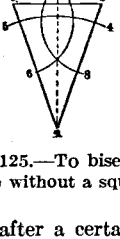


FIG. 125.—To bisect an angle without a square.

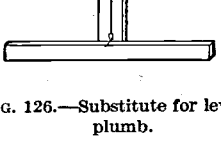


FIG. 126.—Substitute for level-plumb.

Thus, after a certain length, say 6 inches, has been laid off on each arm of the instrument, the measurements being taken of course from the same point, the square of the hypotenuse of the triangle formed must equal the sum of the squares of the lengths of the two sides. An easier method is to lay off 6 inches on one arm and 8 on the other, after which the two parts are so arranged that the hypotenuse is 10 inches. This instrument may also be used as a level-plumb if a plumb-bob is attached as shown.

SHEARS

These are used in the erection of long, heavy timbers when the draft is to be from a point at the ground. Their function is to raise the direction of draft, which would otherwise be almost parallel with the long dimension of the timber to be erected. They should be half as long as the timber to be erected and of a diameter that will prevent buckling under endwise strain. They are first laid with the upper ends crossed on the timber, the lower ends being placed one on either side of the timber, and at a distance from it sufficient to present a suitable base as the timber is raised. Shallow holes are dug as receptacles for the lower ends and are supplied for the purpose of preventing the shears from "kicking out" at the bottom when the

draft is applied. The upper ends are fastened securely together at a point about 12 inches down. At or near the upper end, of the timber a cable is attached and then brought down to where the shears cross each other. Here it is securely fastened to the shears at a point on the cable far enough from the end of the timber to allow the shears to rise at an angle of about 45 degrees before any draft is applied to the timber. Tackle ropes will not work through the cross of the shears and the

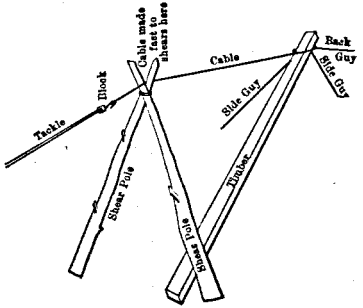


FIG. 127.—Erection of timber with shears.

cable must therefore be supplied with an eye for the reception of the hook in the block. A back guy and two side guys are then attached to the upper end of the timber, the back guy being snubbed about a post and paid out as the timber is raised, but the side guys being fastened securely to posts set in line with the foot of the timber and at right angles to the line of draft. Posts for the side guys must be set at a distance from the foot of the timber equal to the distance from the foot to where the guys are fastened to the timber. The tackle is taken in by means of a crab.

GENERAL FIELD WORK

RIDING

Since good saddle animals cost from $80.00 to $125.00 per head, it is quite to the advantage of an inexperienced man to know what constitutes proper and improper riding.

One important fact he should bear in mind is that it never pays, in any circumstance, to purchase vicious, diseased, crippled, partially blind, or otherwise defective animals. Since a large part of his time must be spent in the saddle he will find that even the best horses are none too satisfactory, and the use of inferior animals will only tend to make his work more unpleasant.

SADDLING

Adjusting the Blanket.—Without doubt, one of the most common causes of a saddle animal's sore back is an improperly constructed or badly adjusted saddle blanket. The first thing to be done in securing a proper adjustment of the blanket is to see that both the top and under sides are free from burrs, twigs, leaves, and other similar articles that may abrade the animal's back or cause sitfasts or galls. (See page 255.) After this precaution has been observed, the blanket should be placed so it will fit squarely and evenly under the saddle, allowing as nearly as possible an equal pressure along either side of the animal's backbone downward to a distance somewhat below the edge of the saddle bars or even to the lower edges of the skirts. If the blanket is one that must be folded several times care must be taken to see that the edges of the folds do not come where great pressure of the saddle will occur. These folds should be made to fall below or to the front or rear of the saddle skirts. Heavily ribbed blankets require special attention in being so placed as to bring the ribs parallel with the skirts. Any blanket that has been wet and then allowed to dry quickly and become stiff should be worked pliant and scraped clean of all incrustations of dirt and sweat.

Placing the Saddle.—After the blanket has been properly adjusted, seize the saddle horn or fork with the right hand, and

the lower front corner of the near skirt with the left, then swing the saddle upward over the animal's back to a height that will permit it to be lowered squarely on the blanket. This operation is performed from the near side of the animal. The saddle should not be lowered to the blanket with violence nor should it be swung in such a manner as to cause the off stirrup or the loose end of the cinch to strike the animal a severe blow on the leg or side. If saddling is done in this manner, any horse will soon acquire the habit of shying out from under the saddle as it descends. If the saddle has been properly placed, the off skirt and stirrup and the cinch will fall into their proper positions, and the saddle is then ready to be cinched.

Tightening the Cinch.—The front cinch of a double-rigged saddle is fastened first. To do this, the left hand is thrust beneath the animal's body, the cinch is secured and brought up to the near side, and the latigo is then threaded through the cinch ring from the inner side with the right hand. Afterward, the latigo is passed upward and through the ring in the rig from the outer side, downward again through the cinch ring from the inner side, then upward and tied into the rig, as shown in Fig. 228. If the latigo is made to buckle, the buckle-tongue is thrust through it, and the loose end is then disposed of by hanging it in the loop provided for that purpose, just under the near side of the fork. Care must be taken to see that all slack in the latigo between the rig and the cinch has been taken up, or the buckle-tongue may work loose and allow the saddle to slip.

After the front cinch has been fastened the rear cinch is treated in a similar manner except that it is not drawn as tightly. If a cinch fastener (see Fig. 11) is used, the latigo must be drawn tightly enough to force the lower end of the fastener lever outward against the lip of the loop. Unless this is done the cinch ring may slip from the loop and thus leave the saddle without any fastening whatever.

Neither cinch of a double rig should be fastened too loosely. As a general rule, the front cinch may be given an extra tightening after the animal has been ridden 300 or 400 yards. By that time the blanket is firmly settled and the animal, if he is a "sweller," has resumed his normal girth, so the saddle may be fastened for a long ride. The cinch should not be drawn up close against the animal's elbow joints but should rest to the rear of them at a distance of from 1 to 2 inches.

It is seldom necessary to draw the rear cinch very tight. When this is done the animal suffers more or less inconvenience and discomfort in breathing and will in most instances object strenuously to such treatment. This cinch should be drawn snugly against the body, however, and not left loose enough to rub against the ends of the hair and produce a tickling sensation.

Removing the Saddle.—The rear cinch is loosened first and the latigo end is either thrown upward across the saddle or else hung in the loop provided for it. When this has been done the front cinch is loosened and the latigo is disposed of in a similar manner. This disposition of the latigoes obviates the possibility of their becoming entangled in brush or about the horseman's legs as he moves away from the horse.

In removing the saddle the horn or fork is seized with the right hand and the blanket is caught by the left. By thus securing the blanket it is kept from the ground, where it might accumulate dirt or burrs. When a firm hold has been secured at the fork the saddle is dragged from the animal's back by pulling it toward the near side. It is then laid on its side or stood on end, fork downward. If thrown flat down on the skirts the latter soon lose their shape and curl in or out or otherwise become twisted and wrinkled. Moreover, the skirt linings may pick up twigs or burrs or become damp or dusty. The blanket should be thrown, sweaty side downward, across the saddle. Both blanket and saddle should be placed in the shade during hot, dry weather.

Mounting.—This operation should always be conducted from the near side and only from the off side when circumstances absolutely demand it. Nothing indicates a man's inexperience with horses or emphasizes it more strongly than his attempt to mount from the off side, which usually results in disaster when western horses are to be ridden. They are seldom trained to expect such handling, and are naturally more or less puzzled or surprised when the inexperienced man introduces the novelty. Practically all of the saddle animals found on the farms of the East and South, and in many parts of the North, may be mounted with equal facility from either side, but they are so trained merely as a matter of convenience and the rule should never be assumed as a general one. It is well to learn to mount from either side in order to be prepared for emergencies, but it is never advisable to try experiments with strange horses.

Various styles of mounting prevail in different localities, and each has its advantages and disadvantages according to the animal to be ridden and to the manner in which it has been trained or "broken."

Cheeking.—This method is common to all parts of the West and is the safest method by which a fractious or viciously inclined animal may be mounted. The horseman secures a firm grip of the near bridle cheek with his left hand and with the right then turns the near stirrup forward until he can insert his left foot in it as he stands facing almost rearward. When his left foot has been firmly placed in the stirrup he releases the latter and then grasps the reins and saddle horn with the same hand; in some cases the reins are held with the bridle cheek in the left hand. He hoists himself into the saddle by a muscular effort of the right arm and left leg. If the animal attempts to pitch while it is being mounted it is prevented from doing so by the reins held at the saddle horn, or drawn in with the left hand. These should be drawn in short enough to hold the animal's head well up. No horse can pitch until he can lower his head.

If it makes a sudden lunge the grip on the bridle cheek serves automatically to hold the horseman near the animal and pull it under him rather than allow it to move in an opposite direction. This method of mounting also keeps the horseman well to the front and out of the danger zone if the animal kicks. If it is impatient and attempts to start unmounted, it is forced to travel in a circle about the horseman, and the latter is thus materially assisted in his efforts to mount.

Another method of mounting common to the West is to seize the mane with the left hand. Except for this difference the method is the same as cheeking.

Vaulting.—This method of mounting is used chiefly on moving animals. The rider secures a firm grip of the saddle horn with one or both hands, uses his elbows as a fulcrum against the horse's side or the side of the saddle, and thus assists himself in springing high enough to pass his right leg over the cantle and to alight squarely in the saddle seat.

This is the quickest method of mounting that can be used, and it may be employed to great advantage when a swiftly moving animal is to be mounted. In such a case, if the grip at the horn is secure, the momentum of the horse will almost

throw the horseman into his seat if he exerts only the slightest effort in springing upward from the ground. Care must be taken, however, not to spring too forcibly or the horseman will invariably throw himself completely over the horse. Such an accident may appear quite improbable, but as a matter of fact the novice will throw himself too far rather than not far enough, and unless the saddle is well cinched and his grip at the horn is very secure he may experience a serious fall.

"Climbing On."—Throughout the East, in some portions of the South, and in many parts of the North and central West, a very common method of mounting is to insert the left foot in the proper stirrup, seize the reins and the saddle horn with the left hand and the cantle with the right, and then "climb on" a horse. This method of mounting is perfectly safe when a well-trained animal is to be ridden, but should never be attempted on a spirited or half-trained horse.

Position.—The inexperienced rider invariably assumes an unnecessarily stiff and unnatural position in the saddle. and this results in his extreme lameness for several days. Moreover, such a method of riding, by reason of the resultant unyielding seat, has a tendency to tire a horse and may even have serious effects upon one so ridden. The only muscles in the rider's body that must be held in a reasonably prolonged degree of intensity are those which enable him to maintain a thigh grip against the sides of the saddles. This grip is necessary in order to prevent him from being unseated in case his mount shies suddenly or unexpectedly, or whirls or makes a sudden swerve from the general direction of travel. It also assists him in maintaining his seat at other times and prevents, to a great extent, the unpleasant sensation of "bouncing" when a horse travels otherwise than at a walk. The action of this set of muscles soon becomes involuntary and requires no attention on the part of the rider.[1]

The English style of riding, known as "posting," where the rider raises his body from the saddle at regular intervals throughout an animal's progress, is to be avoided. It is tiresome to the rider, injurious to his mount, and can not be justified by any

[1] Frequent instances have occurred where greatly fatigued or sleep-worn cavalrymen, and others whose duties require continual riding, have been known to fall sound asleep and in this condition maintain their seats throughout miles of travel.

rule of practice or elegance. Aside from these facts, it is even dangerous in fast riding over rough country or in brush.

Another common practice among a certain class of careless riders is to "ride the stirrups," *i.e.*, stand in them in such a way as to remove the weight of the body from the saddle seat. It is never employed by the best riders, except occasionally in very rough traveling, such as fast downhill trotting or over uneven ground where an animal may be expected to fall and in doing so compel instant dismounting.

Another practice to be avoided is "riding one stirrup." In doing this the rider removes one foot from the stirrup, raises the corresponding thigh into the saddle seat, and rests practically all of the weight of his body on the foot in the other stirrup. On long, hard rides an occasional change to this position for short intervals is restful to both the rider and his mount, but when maintained for extended periods it usually results in injuries to the animal's back. This is due, of course, to unequal pressure of the saddle. For the same reason the practice of crooking one knee about the saddle horn and riding sidewise for long intervals is likewise bad.

The easiest position, and one that produces a minimum of discomfort for both horse and rider, is a firm thigh grip and a reasonably loose seat, the backbone kept firmly upright but not rigid. If the animal is inclined to buck or pitch the thigh grip is especially advantageous. In such a case the rider should lean well back of the perpendicular in order that the momentum created by the animal's sudden starts forward may be counterbalanced. An attempt to hold the animal's head up and thus prevent it from bucking usually results in the animal throwing itself. The common idea that a horse is assisted in recovering its equilibrium if the reins are held tight is erroneous. At such times it needs all possible freedom of the neck muscles.

If a saddle animal develops the habit of rearing and falling back while under the saddle, great care must be exercised in dismounting as quickly as possible. This may be done by placing one hand either side of the saddle horn, against the fork, and springing backward from the saddle; or the rider may dismount to one side. In either case he should spring from the saddle with sufficient force to throw himself clear of the animal and prevent it from falling upon him. At the instant the animal starts to regain its feet he should remount; otherwise such an

animal, believing it has at last found a means of ridding itself of the rider's weight, will persist in the habit.

Reins.—These are held in the left hand, leaving the right free for the use of a rope, quirt, or other articles. Usually reins are tied together, although many riders prefer them separate, or "split." When used in the work of roping stock they are either in one piece or else tied together so they may be hung over the animal's neck or the saddle horn and not interfere with the use of the rope or the progress of the horse. The length, however, in general field work, is a matter of personal opinion, and nothing more definite on the subject can be offered here.

Reining.—This is simply the operation of guiding a horse. A very common method, especially common to all parts of the West, is known as "neck" reining. By this method a horse is turned to the right by laying the near rein against the left side of his neck just before the shoulders. He is turned to the left by a similar pressure of the off rein on the right side of his neck.

In many sections of the West, where stock must be handled from horseback, saddle animals are trained to stop when the reins are dropped to their necks. Ordinarily they are started again by a thrust with the spurs.

Another common method of guiding and stopping saddle animals is known as "legging." By this method the rider turns his mount to the left by pressure of his knee against that side, or, if personal likes dictate, he trains the animal to turn in the same direction by pressure of the other knee. The animal is stopped by pressure of both knees simultaneously.

In most parts of the East and South a saddle animal is turned by a pull at the bit on the side to which it is to turn.

Dismounting.—A practical knowledge of this operation is perhaps more important than knowing how to mount, and, like the latter, is accomplished in different localities in different ways. The safest method is to grasp the saddle horn firmly with the right hand, holding the reins securely in the left; the right foot is then withdrawn from its stirrup, the left foot is moved backward till the balls of the toes rest in the stirrups, the right leg is passed backward over the cantle and downward to the rear of the left leg, and the left foot is finally released from the stirrup by tipping the heel downward. This enables the horseman to alight squarely upon both feet at the same time, and still leaves

him facing in the same direction in which the animal has been or still may be traveling.

By holding the reins in his left hand he is able to check his horse's speed, while with his right at the horn he steadies himself until a proper equilibrium is obtained. He is also held well to the front and out of danger of being trampled upon or kicked.

This is the safest and about the only practicable method that can be used in dismounting from a rapidly moving animal. In such a case the rider must, of course, balance himself temporarily against the horse's left side before he releases his left foot. Very little practice will enable him to dismount while the horse travels at breakneck speed.

It may appear to the inexperienced field man that a knowledge of such a method of dismounting would seldom be put into effect, but when he considers that cattle or horses may have to be roped and then tied down before they can arise, or that a stray sheep or lamb must be captured and its earmarks read, or a falling or rearing horse may compel him to dismount as quickly as possible, he will see that such knowledge will not come amiss.

Another method of dismounting, particularly common to the South and known in the West as "backing out," is to grasp the saddle horn and the reins with the left hand and the cantle of the saddle with the right after the right leg has been thrown backward over the cantle, then, turning the body till the rider faces the animal, dismount by stepping down backward from the stirrup. This is safe enough with gentle and well-trained animals, but should not be used if fractious or partly broken animals are being ridden. The possibilities of having a foot hang in the stirrup and of an animal's sudden attempt to escape are too important to overlook.

Throughout the West saddle animals are usually trained to stand without being tied, the rider simply throwing his reins to the ground at the time he dismounts and making no further effort to confine the animal. It is very important that this custom be borne in mind, since if such animals are left with the reins hanging about the saddle horn, they frequently stray away or may even bolt and run to a distance that makes their capture a matter of considerable difficulty.

PACKING

In many sections of the West, where travel facilities are limited, supplies and equipment must be carried from place to place on pack animals. This is not as awkward a means of conveyance as it may seem. If the packer understands his work thoroughly and is possessed of considerable ingenuity he will have little or no difficulty in fastening a pack so it may be carried for a long distance. The load may be a cook stove, telephone wire or poles, fence posts, grain, bedding, fire-fighting tools, or water, or it may consist of a number of other articles, all of which may be transported in a very satisfactory manner if properly loaded and secured to the pack saddle.

Three important things to remember are: (1) A load that must be carried for a considerable distance should not exceed two hundred pounds in weight;[1] (2) The weight must be equally divided between the two sides of the pack; (3) The load must be firmly tied to the saddle but in such a manner as to permit quick unloading if the pack animal falls, becomes entangled, or otherwise requires immediate relief from the load. A pack weighing one hundred pounds is much more wearisome to an animal than the weight of a man weighing one hundred and fifty pounds. This is due to the fact that the pack is "dead" weight and either maintains the same position at all times or else slips about over the saddle with sudden, unyielding movements that soon tire the animal. If the man is a reasonably good rider he may shift his position and weight in such a way as to assist an animal in traveling over rough country. "One-side" packs, or packs so placed that the greater part of the weight is on one side, soon turn unless very securely tied. If they can not turn they soon injure an animal's back.

Complicated knots to be used in packing are not only difficult to tie, but they may even prove disastrous if a fallen animal is to be quickly relieved of its pack. The simplest knots that will hold are the ones to be used, possible opinions of old packers to the contrary notwithstanding.

[1] An instance of unusual physical power in a pack animal is of authentic record in central Arizona, where a 700-pound piece of mining machinery was carried a distance of ¼-mile by a mule that weighed nine hundred pounds. The animal experienced no apparent ill effects from such exertion.

HITCHES USED

Grain Hitch.—This hitch is not required if panniers are to be used. Its use is confined chiefly to fastening sacks of grain or other loose articles to the pack saddle. Its construction as applied to the near side of the saddle is shown in Fig. 128. The off side is tied in a similar manner, the rope being 30 feet long and ½-inch in diameter.

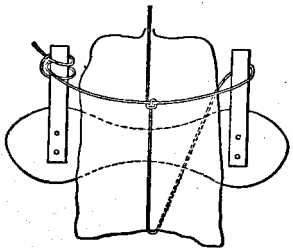


FIG. 128.

This is somewhat longer than is absolutely necessary in tying the hitch, but being of that length, if the loose ends are so long that they can not readily be disposed of otherwise, they may be cut off and used as halter or tie ropes. It is given a clove hitch about the front fork of the saddle as shown in Fig. 129, the ends emerging from the front side of the hitch. A half-hitch is then taken about the rear fork, as shown in Fig. 130, the off end of the rope being used first and the near end in a similar

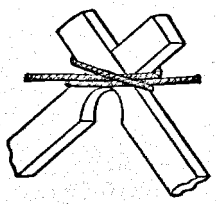


FIG. 129.—Clove hitch about front fork of pack saddle. Front view.

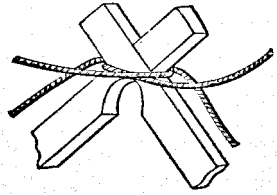


FIG. 130.—Loops about rear fork of pack saddle. Rear view.

manner later. The packer then shoulders the article to be packed, raises the length of rope passing from the front to the rear fork, and drops the load between it and the saddle, the loose end of the half-hitch passing up under and around the sack as shown in Fig. 128. This is fastened to the horizontal length of rope as shown in the same figure and the end is left

loose until the opposite side is loaded, the off side frequently being loaded first. The horizontal length of rope can best be tightened by pulling downward on the half-hitch. The two loose ends of rope are tied together after both sides of the pack have been loaded. After the ends have been crossed over each other a half-hitch in one may be turned about a loop in the other, thus providing a knot that may be released instantly by a pull at the loose end of the rope.

It should be remembered that the clove hitch about the front fork can not be slipped and that the rope must therefore be loosened at the rear fork first. This will permit the horizontal lengths to be pulled out far enough from the pack to let the pack fall through the loop to the ground.

Diamond Hitch.—There are a number of varieties of the diamond hitch, but only the one most widely used can be discussed here. It is suggested that the beginner familiarize himself with this

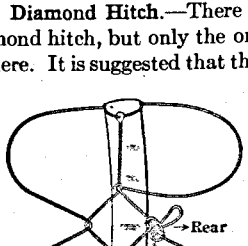


FIG. 131.—Top view of diamond hitch.

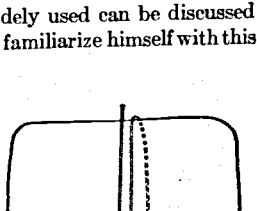


FIG. 132.—First position of lash rope. Near side.

form first and that he learn other forms after he has mastered it. A common mistake made by amateur packers is their propensity for trying to learn all the different forms of hitches used in packing before they are thoroughly versed in the use of one.

The diamond hitch described here and illustrated in Fig. 131 can be applied without difficulty by one man and will be found very convenient in fastening down the top pack. This part of the pack consists of bedding, tents, etc., usually carried over the grain or other articles confined by the grain hitch, and care must be taken to see that it is evenly balanced. Bedding should

be wrapped in a tarpaulin or tent before it is packed. The canvas protects it from rain and brush.

The lash rope should be 30 feet long and ½-inch in diameter. If there is good reason to believe that there will be no occasion to use it except for packing purposes then the end may be made fast to the ring in the lash cinch by means of an eye splice. Otherwise it should be merely tied into the ring so it can be removed with less difficulty. When the pack is ready to be lashed down the lash cinch is thrown over it from the near side, the packer catches the lash hook as it swings upward from beneath the animal's body, hangs it over the lash rope with the open side of the hook to the rear, and then passes the rope upward along itself to the top of the pack, allowing 2 or 3 feet of the end to remain on the near side. This is the first position of the lash rope and is illustrated in Fig. 132. He then takes a bight, or bend, in the second length about the first length at the top of the pack as shown in Fig. 133, passing the second twice around the first and from the upper side. The loose end is passed to the rear, downward, forward under the off grain pack, upward around the off forward part of the top pack, through the bight, downward around the near forward part of the top pack, rearward under the near grain pack, and upward around the near rear part of the top pack to the first length of rope over the pack. It is tied here in an overhand loop knot and the hitch is completed as shown in Fig. 131. To be effective the hitch must be drawn very tight. This is done by beginning at the hook and successively tightening each length.

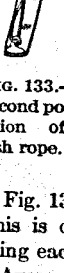


FIG. 133.—Second position of lash rope.

Axes, picks, rakes, shovels, crowbars, tripods and other similar instruments may be thrust through under the ropes after the hitch has been completed and made fast. This not only holds them more securely, but also serves to tighten the ropes about the pack. Instances may occur, of course, where such a method of loading these articles is not desirable, and in such cases they must be placed on the pack before the ropes are tightened and tied. Care must be taken to see that the forward ends do not project upward or forward to an extent that may cause them to hang in brush or against low branches.

The ax should always be so fastened to the pack that it may

be removed quickly and without difficulty. Picket ropes, hobbles, bells, morrals, canteens, and other such articles may be distributed about over the pack at the most convenient points, but none of them should be allowed to hang loose and dangle or hang in brush.

The hitch is released by pulling the loop from the overhand knot. This usually loosens the rope enough to permit removal

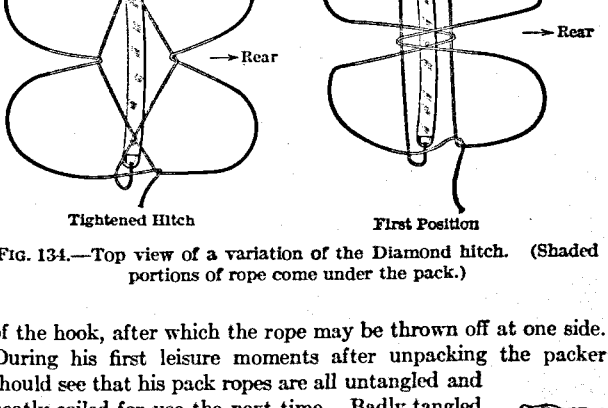


FIG. 134.—Top view of a variation of the Diamond hitch. (Shaded portions of rope come under the pack.)

of the hook, after which the rope may be thrown off at one side. During his first leisure moments after unpacking the packer should see that his pack ropes are all untangled and neatly coiled for use the next time. Badly tangled or misplaced ropes are a great inconvenience when hurried packing becomes necessary or when bad weather makes the work unpleasant. A variation of the diamond hitch is shown in Fig. 134. This is a favorite hitch among wood packers, and aside from being especially effective for such use is so quickly and easily applied that little time is wasted. It differs from the first form of the diamond hitch shown in that each successive length of rope is tightened as it is reached. The cinch is usually passed beneath the animal's body from the near side, thus allowing the final tightening to be done from the front rather than at the rear of the animal.

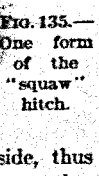


FIG. 135.—One form of the "squaw" hitch.

Squaw Hitch.—This hitch also requires the services of two men. In one form of the hitch the rope is double at about one-third its length and the loops 1, 2, and 3, shown in Fig. 135, are

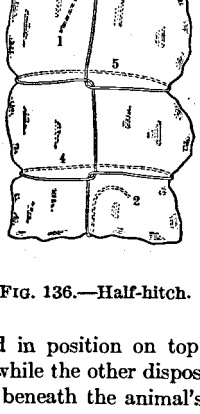


FIG. 136.—Half-hitch.

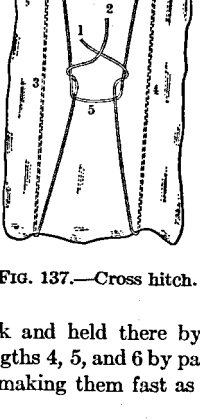


FIG. 137.—Cross hitch.

placed in position on top of the pack and held there by one man while the other disposes of the lengths 4, 5, and 6 by passing them beneath the animal's body and making them fast as indi-

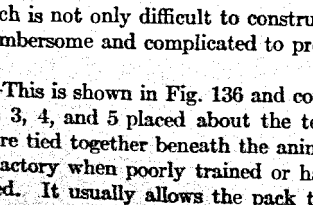


FIG. 138.—Bed roll ready for transportation by wagon.

cated. The hitch is not only difficult to construct properly but it is also too cumbersome and complicated to prove satisfactory otherwise.

Half-Hitch.—This is shown in Fig. 136 and consists merely of the half-hitches 3, 4, and 5 placed about the tent or bed roll. Ends 1 and 2 are tied together beneath the animal. The hitch is very unsatisfactory when poorly trained or half-broken pack animals are used. It usually allows the pack to turn sidewise

or slip forward or backward, and thus requires continual readjustment.

Cross Hitch.—This hitch is tied at the top of the pack as shown in Fig. 137. The lengths of rope 3 and 4 pass beneath the animal's body. It possesses the same disadvantages as the half hitch.

WAGONS

The use of wagons by field men in the Forest Service is very limited except in transporting camp equipment or supplies in reconnoissance work or on extended camping trips and in hauling provisions, feed, and other supplies into camp or to Ranger stations.

Occasionally, however, they may be required in improvement work such as road- or trail-building or construction of telephone lines and other similar work. They are seldom purchased outright but are frequently hired for temporary use unless the field man has one of his own which he is willing to use in official work. Nevertheless it is well for him to know what type of wagon is best fitted for the work to be done and to secure strong, reliable wagons in preference to others that may require constant repairing. It is seldom possible to find an ideal wagon for hire, but if one is selected as nearly as possible in accordance with the following suggestions it will give general satisfaction:

Type.—Since practically all wagon work done by the Forest Service is in rough, mountainous country a regulation mountain wagon is most desirable. This is of the narrow-track style, being 4 feet 6 inches from center to center of the tires on the ground.[1] It carries a 38-inch bed, weighs approximately twelve hundred pounds and has a safe carrying capacity of thirty-five hundred pounds.

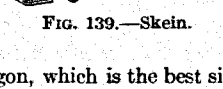


FIG. 139.—Skein.

Size.—The size of a wagon is determined by the outside diameter of the skein at its shoulder and by the length of surface presented to the boxing of the hub. Thus a 3 by 9 wagon, which is the best size for general work, has skeins 3 inches in diameter at the shoulder with a 9-inch bearing length. See Fig. 139. The size will be found stenciled on the back of the rear bolster.

[1] A wide-track wagon measures 5 feet from center to center of the tires on the ground.

Wheels.—Regular size narrow tires for 3 by 9 mountain wagon wheels are 1½ inches wide and ¾ inch thick. They may or may not be secured to the felloes by means of tire rivets. The latter are inserted between the felloes and the tire and are rivet-headed at each end. Some manufacturers claim that they are detrimental to a wheel by reason of the fact that in hot, dry weather, during which the felloes shrink and the tires expand, they have a tendency to split and batter the felloes as the tire is forced sidewise on rough roads. They also assert that the rivet heads soon wear away, allow the rivets to work out, and thus cause the tires to loosen more quickly. These objections to tire rivets or bolts are logical so far as they go, but when tires are so loose as to allow the rivet heads to batter the felloes they should be reset as soon as possible. Moreover, especially in regions remote from repair shops, it is much better to have a loose tire secured to the felloes than to have it run off and allow a wheel to be broken down.

Felloes and hubs, the latter well ironed, should be of seasoned white oak (*Quercus alba*). Spokes should be of seasoned second growth white oak or hickory (*Hicoria ovata* or *alba*). The regular number of spokes in a wheel is twelve front and fourteen rear, but those which bear fourteen front and sixteen rear are about one-sixth stronger than the others. A wheel height of 44 inches front and 52 rear will be found most satisfactory for general work.

Two very widespread though erroneous ideas with reference to wheels are that when a wagon sets on approximately level ground the front end of the bed is lower than the rear, or that, in the same position of the wagon, the rear end of the bed is lower. The first is no doubt based on the supposition that the fore wheels, being smaller in diameter than the rear wheels, necessarily lower that end of the bed. The second probably originates in failure to observe the difference in diameter of fore and rear wheels, and is merely an assumption that since the front end of the bed comes even with or above the wheel top, while the rear end is considerably lower than the rear wheel top, the rear end of the bed is consequently lower. As a matter of fact, except when the construction has been for some particular purpose, a wagon gear is usually so constructed that when it sets on level ground the bed is also level. Fore wheels are made smaller than rear wheels in order not only to provide

room for the sand board and usually heavier rocking bolster, but also to facilitate turning the wagon about in close quarters.

The smaller circumference of low wheels allows them to drop into ruts over which higher wheels pass with greater facility, and since less leverage is provided by the short spokes such wheels make a wagon pull harder on rough roads than if it were fitted with high wheels.

Dish.—Each wheel should have a dish equal to one-half the width of a regular narrow tire, and the tires should be strong enough to maintain such a dish. Wheels without dish are no stronger than the spoke tendons in the hubs, and a very light load, or even the weight of an empty bed, carried over a rough road may force the hubs through.

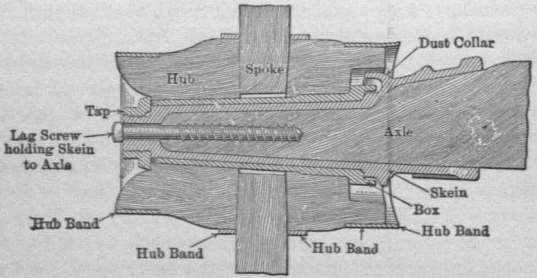
Wagons should not be hired if their tires have been set so often as to produce excessive dish. In such wheels the spokes do not stand perpendicularly under the load and can not therefore support a heavy weight. Moreover, they cause the rims to bind in ruts, they destroy the proper pitch and gather, and they are generally unsatisfactory to use.

Gather.—This is provided for in fitting the skein to the axle. The object of such construction is to force the hub toward rather than away from the shoulder of the skein when a heavy load is being carried. Otherwise the wheels of the same pair would have a tendency to pull away from each other and thereby offer much greater resistance to the road. Properly gathered wheels of the same pair are from 3 to 4 inches nearer each other at their forward circumference than at their rear circumference.

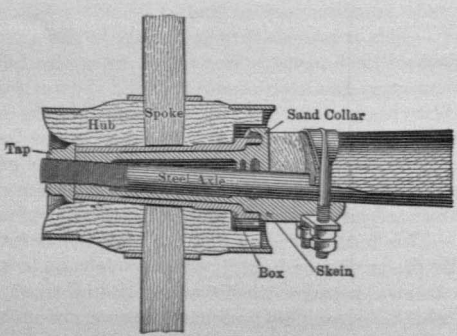
Pitch.—This term is known in some localities as "tread," or it may be designated as "set." It has reference to the difference in distance between the lower circumference of the same pair of wheels as compared with the upper circumference, in properly pitched wheels about the same as in gather. When it is measured from outside to outside the distance between the rims at the point nearest the ground should be the same as that just under the hub. Pitch is also provided for in fitting the skeins to the axle. It not only brings the weight of the load more in a perpendicular line over the bearing portion of the wheels, but it also serves to hold the hubs against the shoulders of the skeins and counteracts the wheels' tendency to run off.

Track.—This term has reference to the action of the rear

wheels in following the track of the fore wheels. It is at once apparent that unless the construction is such as to permit this the rear wheels will offer greater resistance to the road and the draft must be increased accordingly. Difficulty in this respect



Method of attaching skein to wood axle.



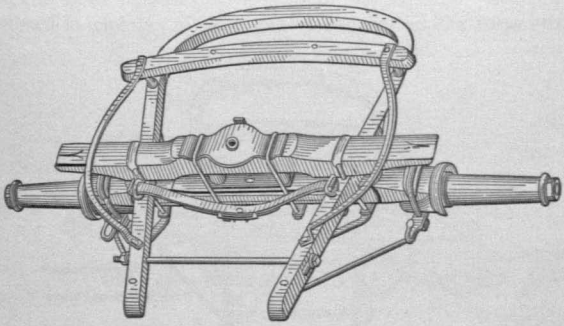
Method of attaching skein to steel axle.
FIG. 140.

may be due to a crooked reach or tongue, excessive dish may be present in one or more wheels, the skeins may not be properly fitted to the axle, or the boxing may not be squarely set in the hubs.

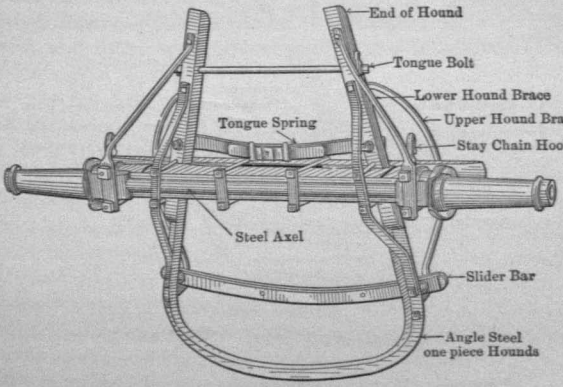
If the wheels track and have the proper pitch and gather a wagon may be run over a smooth road without taps so long

as the direction of travel is forward. The gather will of course force the wheels off soon after the wagon is started backward.

Skeins.—These should be given a very thorough examination before a wagon is hired. If it has had considerable wear this



Top view.



Bottom view.

FIG. 141.—Front gear. (Steel axle.)

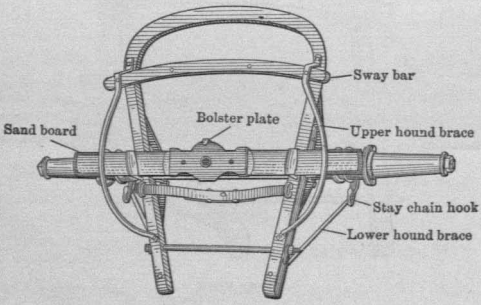
will be apparent at the shoulder. It will be especially prominent at the upper side of the shoulder and the lower side of the point if the pitch has been lost. Lost gather will be indicated

by wear at the rear side of the shoulder and the front side of the point.

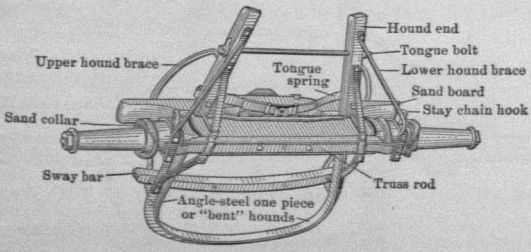
Skeins are attached to axles as shown in Fig. 140.

GEARS

Hounds.—This is sometimes spelled "hawns," and this form of the word will be frequently met with in catalogs of hardware



Top view.

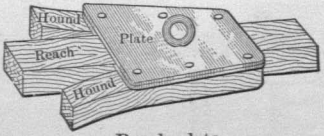


Bottom view.

FIG. 141*a*.—Front gear. (Wood axle.)

and woodenware. They should be of seasoned hickory or white oak and well ironed and braced. See Figs. 141 and 141*a*. The front end of the rear hounds should be bolted securely together through the reach plate as shown in Fig. 142. Angle-steel bent one-piece front hounds, wood filled before the axle, are preferable to all-wood square hounds by reason of the fact that there is

less surface exposed to brush and stumps. Both front and rear hounds should be well "bushed" or ironed at all points where wear of the reach will occur. This of course puts all the wear



Reach plate.

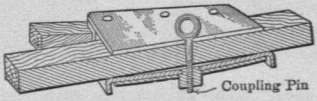


FIG. 142.—Sectional view of reach plate.

on the reach, but when it becomes worn to a degree that requires a new reach this may be secured with much less trouble and expense than hounds or any of their parts.

Front Bolster.—This should be of hickory or white oak, well ironed, and fitted with hollow steel stakes into which longer wooden stakes, known as "false" stakes, may be thrust if high loads of poles, posts, or similar articles are to be hauled. If fitted with iron-bound wooden stakes the irons should be rounded at the lower ends, threaded, and bolted through the bolster rather than bent at right angles and fastened to the upper side of it. The hollow steel stakes are illustrated in Fig. 143. The lower bolster plate, attached to the sand board as shown in Fig. 144, should be equipped with a catch which locks it to the upper plate and prevents the king bolt from being withdrawn by the bolster if a tightly fitting bed is to be removed. It should also have a raised center as shown in the same figure. This prevents wear or breakage of the king bolt and serves to steady a top-heavy load. This bolster is known also as a "rocking" bolster.

Rear Bolster.—This bolster is rigidly clipped to the rear axle as shown in Fig. 146. Other fittings, except lower plates which these bolsters do not have, should be the same as for the front bolster.

Brake.—A regular mountain brake is shown in Fig. 146 and this style should be used in all mountain hauling. The blocks

should be kept in good repair and should be heavy enough to withstand the hardest usage. They are fastened in the shoes by being beveled inward from the rear edges. The most satis-

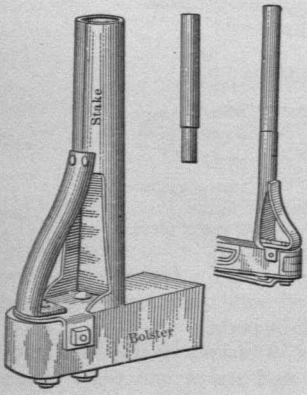


FIG. 143.

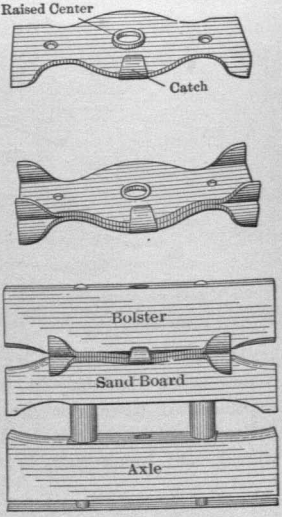


FIG. 144.—Bolster plates.

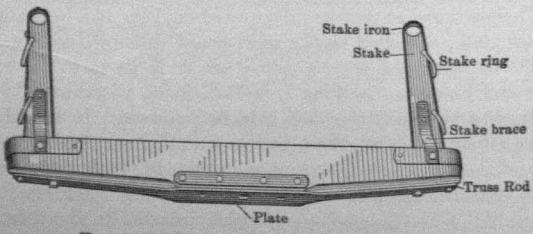


FIG. 145.—Front or "rocking" bolster.

factory and convenient method of keeping them in good condition is to nail pieces of 1- or 2-inch plank to the faces and thereby prevent direct contact of the blocks with the tires. Other pieces

may be nailed on as the old ones are worn through or torn off. Iron shoes will be found preferable to wooden shoes, as the latter catch grit that soon becomes imbedded in them and causes

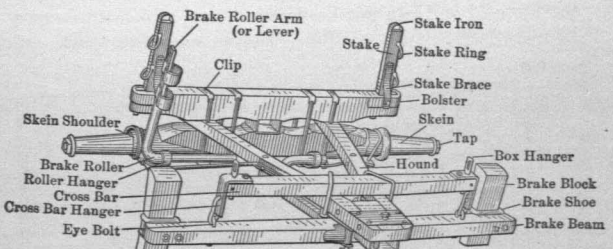


FIG. 146.—Rear gear with mountain brake.

severe wear on the tires. Jump welds in the brake roller are to be avoided, as they may break at a critical moment and cause serious damage to the wagon, team, or driver. The roller is connected with the brake lever, shown in Fig. 147, by means of what is known as the "brake rod." If gear hauling is to be done a pole is thrust into the rings of the roller arm and serves the purpose of a brake lever.

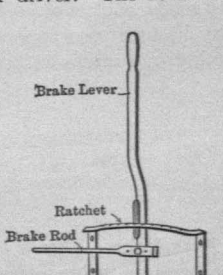


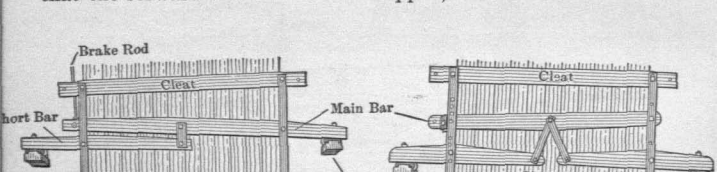
FIG. 147.

Bed brakes with two and three bars are shown in Fig. 148. They can not be used in gear hauling.

Tongue.—Straightness and absolute soundness are the two chief requirements in a wagon tongue. One that crooks to either side or is improperly set in the hounds has a tendency to lead the fore wheels out of the road and is a continual source of annoyance. The forward end should be exactly the same distance from the shoulder of either front skein. If not so fitted, trouble will invariably result. Iron parts should all be fastened down securely and not allowed to project and offer possible means of injury to the team. If more than two horses are to be used the forward end may be fitted either with an iron ring into which a chain may be looped or with an upright hook known as a

"goose neck." The latter is always used when cattle are to be worked, but in such a case the tongue must be shorter and heavier than that used for horses.

Stiff tongues, which are so fastened into the front hounds that the forward end can not be dropped, and which are known



2-bar bed brake. 3-bar bed brake.

FIG. 148.

in most localities as "poles," are not satisfactory when heavy hauling is to be done over rough roads. They whip the team and render control of the fore wheels difficult. Half-drop tongues may be used on comparatively smooth roads, but for all-round work drop tongues are preferable.

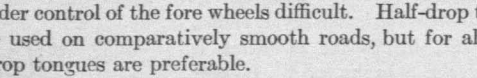


FIG. 149.—Tongue.

Neck Yoke.—This is frequently known as a "breast yoke," the term probably originating from the fact that the article works before the horses' breasts. It should be straight and sound and must be especially reliable if heavy downhill hauling is to be done. This is due to the weight of the load being thrown against it at the center ring. The end ferrules must be kept tight and both end- and center-rings must be strong. The upper side should be ironed if either or both animals in the team are cribbers. See Fig. 150.

Evener.—Another common name of this article is "double tree." It is a very important part of the gears, since the entire weight of the load is pulled directly from its center hole. For this reason it must be of especially strong material free from

flaws, such as knots and cracks or crooked, twisted, or warped grain.

Together with the single trees it is illustrated in Fig. 152.

Single Trees.—In many localities these are known as "whiffle"-trees. They serve as a means of attaching the team to the load,

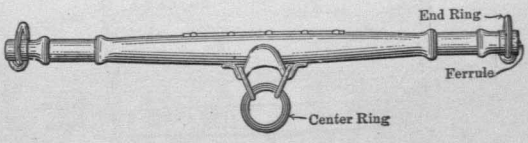


FIG. 150.—Neck yoke

and, like the double tree, must be of very sound material. They should be fitted with a straight center clip and ring, end ferrules rather than loops, and end clips so constructed that the traces of the harness will not work out easily. Substantial clevises fitted with screw pins should be used to attach them to the double tree. If straight pins are used care must be taken to see that they do not work up and allow the clevis to be broken.

FIG. 151.—Evener end. Showing bushing of clevis pin hole.

Bed.—For heavy hauling this should be extra strong and well braced. If numerous boxes, bundles, duffle bags, and similar articles are to be hauled the most satisfactory type of bed is that known as a "rack." This is built in different sizes from 10 feet to 15 feet and 6 inches long, made 38, 42, and 44 inches wide, has from 5- to 8-inch sills, 10- to 14-inch side boards, a tool box at the front end, has an elevated seat and weighs from three hundred and forty to six hundred and seventy-five pounds. Bulky loads may be hauled without difficulty if the side boards are fitted with wings.

The first pair of side boards of an ordinary wagon bed make the sides of the "bottom" box; the second pair make the "top" box; and the third pair make the "tip-top" box. The last are seldom used except in hauling cotton, grain, and similar articles. They are shown in Fig. 153. Rub irons should be in

good condition and thick enough to prevent wear of the tires against the lower corners of the bed. See Fig. 154.

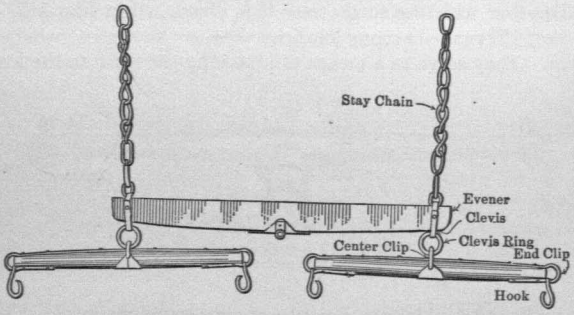


FIG. 152.—Evener and single trees.

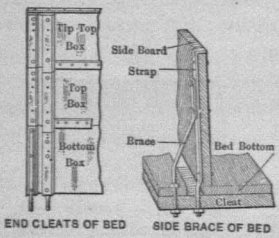


FIG. 153

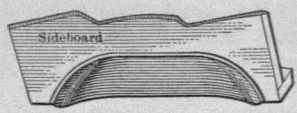


FIG. 154.—Rub iron. "Cut-under" type.

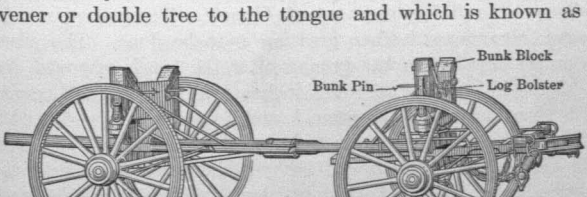
CARE OF WAGONS

Oiling or Greasing.—Oil or grease should always be placed on the upper side of the skein immediately next to the shoulder. The wheel will gradually work it around from there to all parts of the skein and the boxing, and particularly to those points where the greatest pressure comes. Castor oil is the best lubricant that can be obtained, and not more than a thimbleful is necessary for one application. If more than this is used it will work out and be wasted.

Grease may be smeared on the skein with a small paddle short enough to be kept in the grease box. The amount used at one application need not exceed one-half cubic inch, and if

the skeins are greased regularly every day two-thirds of this amount will be sufficient.

Removal and Replacement of Taps.—These operations are performed by means of the wrench-headed bolt which holds the evener or double tree to the tongue and which is known as a



Log gears.

Log gears with log bolsters removed. (For hauling lumber.)

FIG. 155.

"wagon hammer" or "wagon wrench." In removing a tap its edge nearest the front of the wagon is turned upward and backward toward the rear. This rule applies to all four taps, two of which are "left-handed" or "left-threaded." These are the ones on the left side of the wagon. They are replaced of course by turning them in an opposite direction. It will be seen at once that as the result of being screwed to the skeins in this manner they have a tendency to tighten rather than loosen as the wheels revolve forward.

When removed they should not be laid with the greasy side downward but should be so disposed of that the side which works next the boxing of the hub is up. If two or more are removed at the same time and those from opposite sides become mixed they may be identified by a raised letter which

appears on one of the square sides. On taps of the left side this letter is L and on the others it is R. No tap can be screwed on a skein opposite that for which it was intended, although taps of the same side will fit either the front or rear skein of that side.

Removal and Replacement of Wheels.—These need not be completely removed when greasing is to be done. The wheel is simply lifted from the ground after the tap is removed and is then slid outward about 3 inches from the skein shoulder. It is then lowered to the ground, and if necessary tipped further outward to enable the skein to be reached more readily. After the grease has been applied the wheel is tipped back to the perpendicular, lifted straight up, and then slid straight back against the skein shoulder. This method of removing the wheel for greasing is very convenient when no wagon jack is available, and a man with ordinary strength will experience no difficulty in raising the wheel of an unloaded wagon, the easiest way of doing which is to seize a spoke in either hand as he faces the wheel and then lift straight up and slightly outward. In replacing a wheel raised with a jack it should be lifted till the boxing strikes the under side of the skein and then slid back against the skein shoulder.

The coning of skeins and boxing makes it impossible to put a wheel on backward, and the boxing of any wheel in a set will fit any skein of the corresponding set unless special construction is responsible for front and rear skeins of different sizes. In other words, so long as a set is not broken, rear wheels may be used on front skeins, front wheels may be used on rear skeins, wheels of the right side may be used on the left side or wheels of the left side may be used on the right side.

In specially constructed wagons having front and rear skeins of different sizes the skeins of the same axle are of the same size.

Greasing the Bolster Plates.—Many teamsters attempt to make travel easier for their teams by keeping the bolster plates well greased in order to facilitate turning. Turning is without doubt performed with greater ease when the plates are greased, but for this very reason the tongue whips the animals more severely when rough roads are traveled over and the resultant disadvantages far outweigh the advantages gained by greasing the plates. Consequently, the practice is to be avoided except in certain cases when for some unusual reason turning can be accomplished only with difficulty unless the plates are greased.

Tires.—Tight tires constitute the chief factor in economical upkeep of a wagon. Efficiency of a wheel depends wholly upon the strength of the tire and the degree of closeness with which it fits against the felloes. Weak or loose tires, therefore, lessen a wheel's capacity for supporting a heavy load, and if allowed to remain on the wheel will eventually let it break down. If they become so loose that they must be tied or wired to the felloes, they should be re-set immediately. This should not be done, however, by an inexperienced person, but the work should be taken to a competent blacksmith or wheelwright. If tires merely slip to one side they may be forced back into position by slight taps against the exposed felloes immediately beneath those portions which have slipped. They can not be forced into position by blows directed against the projecting edges.

Use of the Brake.—Proper use of their brake is one important feature of good driving that many teamsters overlook, and the usual result is sore necks for the team, damage to the wagon, or even severe accidents to both the driver or his team and wagon. The brake is supplied for the purpose of regulating the speed with which a load descends a grade, and the weight of the wagon, whether loaded or empty, should never be allowed to jam suddenly against the center ring of the neck yoke. Neither should the brake be set at one pressure and left there throughout the entire descent of a grade. It should be regulated in such a way as to keep the load moving at a uniform momentum in descent. Its proper and intelligent use gives the driver almost absolute control of his load at all times, and a little experience will soon teach him just what pressure must be applied under given conditions.

DRIVING

Simple as this work may seem, it is by no means possible for a novice to perform it with success until he has learned three very important things, viz.: To hold the reins moderately taut and not allow them to hang low down between the animals; to speak to the animals in clear, distinct tones little louder than those used in addressing a person; and to use the brake when necessary.

Customarily the reins, or "lines," are held in the left hand and

the brake is operated with the right. The line to the off horse passes through between the thumb and forefinger as the hand is held palm downward and the other line enters the hand from the opposite side, the two crossing beneath the palm. Holding them in this manner permits the driver to turn his team easily with a lateral movement of the wrist. It may be necessary in some instances to allow one line to slip through the hand, especially when short, sharp turns are made, but it may be replaced immediately afterward.

The checks are the shorter lengths of leather that buckle into the line and work across to the bit ring of the opposite horse. They should be adjusted in such a manner that each animal may carry its head straight in line with its body and in a natural position.

The tones used in addressing the team should be moderately loud and very clear and distinct. Most draft animals are trained to respond to certain verbal directions, and if these are muttered indistinctly or issued in loud, angry tones more or less confusion to the animals will be the result. Work animals in many rural districts are guided almost entirely by the driver's voice. Thus he calls out "get up" to start the animal, "haw" to turn it to the left, "gee" to turn it in the opposite direction, "whoa" to stop it, and issues other instructions according to the work being done and to the manner in which the animal has been trained. When the team is to be stopped the brake should be applied in order to assist in checking the progress of the load, and if the team is to be left standing or tied for a considerable period of time the brake should be left firmly set. It should also be applied when the team is stopped for a short rest on a steep grade, and should not be released before the traces have been tightened preparatory to starting. If released sooner it allows the load to start backward down the grade, and this requires a much greater draft to start forward again than the motionless load would. Frequent short intervals of rest on grades are preferable to fewer and longer ones and will prove much more beneficial to the team.

Another important use of the brake is checking the wagon as it crosses short, sharp dips, such as small ravines or large ruts. Many drivers disregard these short grades altogether, but the practice is to be strongly condemned. The whole secret of the proper use of the brake lies in applying it whenever it will pre-

vent the whole weight of the load from jamming suddenly down against the center ring of the neck yoke.

The regulation freight wagon, designed especially for hauling that requires the use of two or more pairs of animals, usually has the brake lever on the near side. This facilitates its use by the driver, who generally rides the near-wheel animal, and who operates the brake by means of a rope passed back to the lever from the saddle horn. Brake levers of trailers are attached to this lever in a similar manner and all are operated from the saddle.

The animal working at the left side in a team of two is known as the "lead," "wheel," or "near" horse, and the other is the "off" horse. Those on the right and left sides in the front of a team of four are known respectively as the "off leader" and the "near leader," and such a team is known as a "four" team or four "span" [1]

A "six" team includes six animals, those between the leaders and wheel horses being known as "middles."

An "eight" team includes eight animals and consists, from front to rear, of the leaders, the "first" and "second" middles, and the wheelers.

A "spike" team includes an extra animal working alone before the leaders, such an animal being known as the "spike."

A six team hauling a wagon and one trailer is known as a "two-six" team. A second trailer makes it a "three-six." Thus a train of freighting wagons including two eight-teams each hauling two trailers, three six-teams each hauling one trailer, and a four-team without a trailer, would be known as "two three-eights, three two-sixes, and a four."

Other combinations of animals and wagons are designated according to the number of each in an outfit.

When using a team of more than four, the driver usually rides the near wheel animal and guides the whole team by means of a "jerk" line attached to the bit ring of the near leader. A steady pull on this turns the leader to the right, while a succession of slight jerks, usually three in number, turns it in an opposite direction. Jerk lines can be used only on animals

[1] The term "span" is usually applied to a pair of mules, but may be, and frequently is, applied to a pair of mares. Its use with reference to horses is limited.

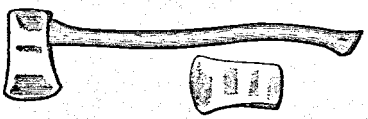
that have been well trained. Poorly trained or fractious animals must be controlled by means of bits and lines.

WOODS WORK

The ranger or woodsman may find it necessary to cut and hew logs for cabins or bridges, telephone poles may be needed, timber and brush must be cut out along roads and trails or felled in case of fire, fuel must be secured, and numerous other lines of similar work may demand his attention. It is, therefore, to his advantage to know how to handle certain tools involved, and he must in any event know something about the use and care of an ax.

Axes.—Contrary to a general idea held by inexperienced persons, there are a number of different styles of axes, each especially adapted to a particular use and many unsuited to other uses. Thus, a broadax, constructed for hewing, is not suited to general woods work; and pole-axes, designed for all-round chopping, are not convenient tools to use for hewing. The marking hatchet, used by officers of the Forest Service in marking certain timber to be removed, is in reality a light ax, but is unsuited to heavy work. A general description of a number of different axes is given merely to serve as an outline of the uses to which they can be put to best advantage.

Pole-ax.—This is made with one round-cornered bit, somewhat longer at the rear than in front, and a square or rounded



Pole-ax.

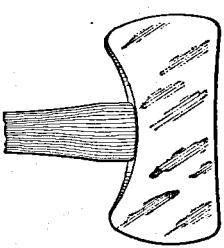
Pole-ax handle.
FIG. 156.

pole, and is fitted with a curved handle, which can be inserted in the eye in only one way. See Fig. 156. The pole may, in emergencies, be used in driving pegs or stakes, but the curved

handle, inverted at such times, makes the ax a very inconvenient tool to use.

Pole-axes may be secured upon requisition for official work. For general use they should be fitted with a 36-inch handle, and should not exceed four pounds in weight. Their cost, including the handle, varies from $1.25 to $1.50.

Double-bitted Ax.—Instead of having a square or rounded pole this ax bears two bits, both in line with the handle, and the latter, unlike that of a pole-ax, is straight with a swell at the end, and is so constructed that it may be used with equal facility with either bit. See Fig. 157. Woodsmen differ widely in their opinions as to what constitutes the best all-round ax,



Double-bitted ax.

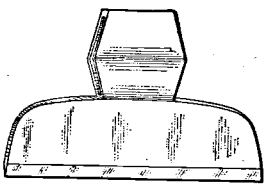
Handle for double-bitted ax
FIG. 157.

but for all purposes work in the woods a four-pound double-bitted ax with 36-inch handle is recommended. The flat side of this may be used in driving stakes or tent pegs; one bit may be used exclusively for such work as may cause it to be thrust intentionally or accidentally into the ground; and the other bit may be kept sharp for felling or for other regular field chopping. If such an ax can not be secured by requisition it can be purchased for about the same price as a pole-ax.

Broadax.—This is made especially for hewing. It has an extra wide bit, with almost square corners, and the bit is beveled only on one side. The eye is so constructed as to permit the insertion of the handle from either side, thus providing for the use of the ax by either a right- or a left-handed person. On ac-

count of the single bevel it is unfit for any use except hewing. See Fig. 158.

Handax.—This is simply a light broadax designed for use in one hand. Ordinarily any hewing that can be done with a



Broadax.

Broadax handle.
FIG. 158.

handax can be accomplished with very little more labor with a common pole-ax or a double-bitted ax. Their inclusion in a camp outfit is not recommended. See Fig. 159.

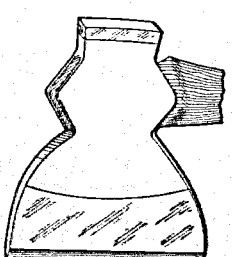


FIG. 159.—Handax.

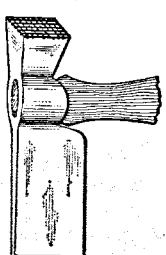


FIG. 160.—Shingling or lathing hatchet.

Marking Hatchet.—This is a light, specially constructed ax supplied the field man for use in marking timber that is to be felled or removed. The pole bears the raised letters US, which are used in stamping Government timber, and the corners of the bit are somewhat more angular than those of the regulation pole-

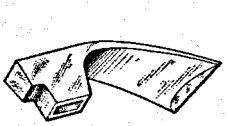
ax. Two lengths of handles are furnished, and for extensive marking or blazing the longer length is recommended. Marking hatchets are supplied upon requisition, and particular care must be observed not to lose one, since it might be utilized for illegal purposes if found and used by an unauthorized person.

Belt-ax.—This is a very small ax with a short handle, sometimes folding, and designed to be carried at the belt of the woodsman. It can be used only in very light work, such as blazing trails, lopping off small branches, or trimming out brush. On camping trips where no other form of ax is available a belt-ax is a very convenient tool, but its inclusion in a camp outfit under any other conditions is not recommended.

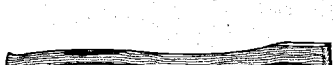
Shingling Hatchet.—This is shown in Fig. 160. The bit is narrow, the front straight, the pole flat and usually rough-surfaced for driving, and the blade is notched at the rear side for pulling nails. The tool is of little use other than for the work for which it is designed, but is a most convenient article for use in shingling.

Carpenter's Adz.—In reality this is a broadax having the bit at right angles to the handle. It is a particularly convenient ax for hewing the upper surface of timbers as the operator stands astride of or faces them. It is practically useless for any other work. It costs from $1.25 to $2.00.

Care of Axes.—*Grinding.*—The manufacturer, in order to secure better protection of his goods in shipping, puts only a blunt edge on an ax and does not expect the tool to be used before



Adz.



Adz handle.

FIG. 161.

it has been properly sharpened. New axes, therefore, can not be used with satisfaction until this has been done. The ax should never be ground on a dry stone, since this will not only heat it and have a more or less detrimental effect on the temper, but will also wear or break the stone away faster. Contrary to a common belief that a better cutting edge may be obtained by turning the stone away from the ax, it may be turned in either

direction with equally satisfactory results both to the ax and to the stone so long as the former is not held at an angle that forces its edge deep into the surface of the latter. The ax should be held against the stone in such a way that the bevel of the bit is ground back evenly and uniformly, leaving the shoulders in the same relative position to the edge as they were before the ax was ground; otherwise the edge will be left either too blunt or too thin. In the former case extra force must be applied to make the edge enter a timber; in the latter the edge will bend or chip away and break.

Whetting.—This is the finishing operation in sharpening. It can best be done by the use of a small stone which can be rubbed against the bit rather than the bit against it. The object of whetting the bit is to remove any rough or "feather" edges that may have been produced by grinding. If such edges are left on the bit they will interfere seriously with chopping.

Filing.—It not infrequently happens that the field man's supply of tools does not include either grindstone or whetstone, and as a result he is forced to use a file for a substitute. Much needless muscular effort will be avoided if the field man remembers that a file cuts only on the forward thrust. If a whetstone is available the ax may be whetted after filing the same as after grinding and much better results will be secured.

Removal of Broken Handles.—The wedge in the end of the handle should, if possible, be withdrawn and the handle then pulled backward out of the eye; but if the wedge can not be removed then the handle should be cut or sawed off close up against the ax and the portion left in the eye driven forward. The wedge will prevent it from being driven backward. If it can be driven neither way, then, if a brace and bit can be secured, several holes may be bored through it and the sections split out one at a time. In an emergency it may even be burned out by placing the ax in a fire, but this will prove injurious to the temper of the ax and should be resorted to only as a last resource.

Making New Handles.—These should be of sound, seasoned, heart white oak (*Quercus alba*), post-oak (*Q. minor*), or hickory (*Hicoria ovata* or *alba*). Sound sapwood of any of these is also good, but the idea that sound hickory heartwood is not as strong as the sapwood is erroneous. Such timber should be straight-grained and free from knots, cracks, and season checks.

The broken handle, temporarily reassembled, may be used as

a pattern by which to mark off the new handle. The latter is then roughly hewn out, dressed down with a pocket-knife or draw-shave, and finally finished with glass or sandpaper. The end to be inserted in the eye should be so shaped as to fill the eye completely before being wedged.

Inserting New Handles.—It is very important that this operation be performed with greatest care if the ax is to "hang" properly. The bit must be exactly in line with the handle, the blade must set perpendicularly to the curve, and the rear corner of the bit must not set too far back. It is always a wise precaution to use the ax in light work for a short time before the handle is wedged in permanently. Dry hardwood wedges are preferable to iron wedges.

Chopping.—This operation, like all others involving the use of a certain tool, is a distinct art that can be acquired only through extensive practice, and there will be no attempt made here to elucidate it except as to the superficial points.

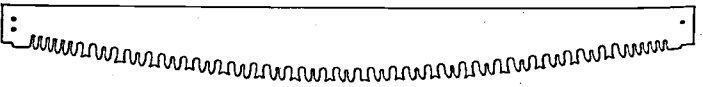
It may be performed either right- or left-handed. In the former the end of the handle is grasped in the left hand, the right being placed approximately half-way down the handle, and the ax is swung over the right shoulder. On the downward thrust, the force is about equally divided between the pushing motion of the right hand and the pulling motion of the left. In left-handed chopping the respective positions and movements of the hands and arms are reversed, and the ax is swung over the left shoulder. Considerable practice is necessary before the bit of the ax can be directed in every instance against a desired spot on a timber, and even after that ability has been acquired there remains the problem of tilting the ax at the proper time and angle required to dislodge the chip and throw it out.

A very common mistake made by novices is their attempts to cut squarely across the grain of a timber. Instead of directing the bit exactly across the grain it should be thrust obliquely into it, unless certain conditions, such as the need for a square-ended timber, for instance, prohibit this.

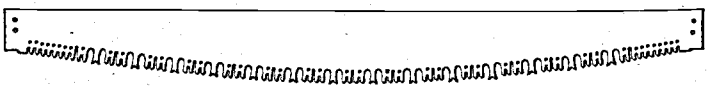
In chopping through a timber it should be notched from one side to or near the center, the notch forming an angle of approximately 45 degrees. The timber is then rolled over and a second notch, cut in such a manner that its apex will meet the apex of the first, is made. If an attempt is made to cut through a

large log from one side the notch will necessarily be so wide that satisfactory results can not be obtained.

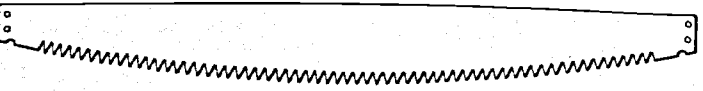
The only general rule for cutting squarely across the grain of



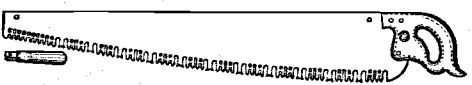
Diamond-tooth saw.



Perforated lance-tooth saw.



Peg-tooth saw.



One-man saw.

FIG. 162.—Two-man saw handles.

a timber is followed in notching a tree that is to be felled, and even in that case the grain is cut diagonally in one direction.

Any operation with an ax is so completely governed by local conditions that only actual experience can dictate exactly what rules to follow.

Splitting.—This operation differs from chopping, as the term is generally used, in that the grain of a timber is split apart rather than severed.

The greatest problem that novices must solve is in keeping the blade of an ax from passing clear through a timber and into the ground. This may be avoided, however, by a slight tilt of the poll to one side immediately after the bit enters the timber.

This not only utilizes the grain at one side of the bit as a fulcrum for the bit to act on against that of the other side, but it also serves to turn the blade from its direct course through the timber and thereby prevents it from sticking fast.

Tough, gnarly timber that cannot be split through the center may be worked up by "slabbing." This consists of splitting off slabs around the outer portions of the timber, gradually working in toward the heart, and finally reducing it to such a diameter as will permit its being split open. Large knots may be split without difficulty by directing a tilting blow against them in line with the grain of the tree.

Saws.—Saws used for general field work may be roughly classed as one-man and two-man cross-cuts, a third variety for light work about camp and other such places being the "buck" saw. For hand-saws, see page 119.

Two-man saws are made in three principal styles, all of which are shown in Fig. 162, and which are known as "Diamond Tooth," "Perforated Lance Tooth," and "Peg Tooth." For any ordinary work none of these should be less than 5½ feet in length. The perforated lance tooth variety is recommended for field use.

This same variety is also recommended in a one-man saw for light work about a station. It will be found especially satis-

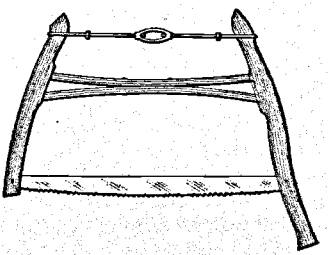


FIG. 163.—Buck-saw.

factory in cutting fuel wood, and is recommended in preference to the common buck-saw.

Buck-saws may or may not be constructed with drag teeth, but if such a saw is to be used it is suggested that one with drags be secured.

The one-man and the two-man cross-cut saws and the drag-tooth buck-saw all cut in both the forward and backward stroke.

Sawing.—Neither man should push a cross-cut saw; it is constructed in such a way as to provide for cutting when it is pulled, but it is too limber to be pushed. The strokes should be full and the whole cutting length of the blade should be utilized. Short strokes, not wearing upon the teeth near the ends of the blade, leave them so long and thick in comparison with the teeth that are continually used that a full stroke of the blade soon becomes impossible.

Each stroke should be even and regular and no extra force should be directed against the teeth to make them cut faster; such saws are so constructed that their own weight will feed the teeth fast enough if these are kept in good condition.

In cutting through horizontal timbers both handles of the saw should be held as nearly at right angles to the log as possible, and should be slightly raised at the outward end of the stroke. This eliminates stiff, unyielding strokes, the cutting edge of the saw being made convex in order to provide for the longitudinal rocking motion thus produced.

In felling timber with a cross-cut saw the latter is of course started into the tree approximately at right angles to it, and in this case must be held against the wood with sufficient force to produce satisfactory progress. The operators may grasp their respective handles with both hands, or one hand may grasp the handle and the other the back of the saw near the handle, depending entirely upon personal ideas of convenience.

Filing.—Examination of a saw will show two sets of teeth, viz.: (1) The cutting teeth, and (2) the drag teeth or "rakers." The first are made in such a way that only a sharp point cuts, and these points are arranged alternately along the blade. The second are forked, have square bits, and are not provided for cutting purposes, but are solely for use in dragging or raking out the chips cut away by the teeth.

In filing the teeth they should be left as nearly in their original shape as possible, a very common failing of saw-filers being their propensity to cut away, or "dub off," the points without filing back the shoulders; this results in blunt teeth that will not cut as clean or as fast as long, tapering teeth.

Particular care must be observed to have the teeth all the same length after the saw has been filed; if some are left longer

than the others the saw will jump or hang, feed to one side, or otherwise prove disagreeable to work with.

Rakers should be left slightly shorter than the teeth, or they will prevent the latter from entering the wood and a rough, jerking motion in sawing will be the result. They should be left short enough so that when the sawyer looks along the edge of the blade he will observe a shallow groove, the ends of the rakers forming its bottom, and the short sides of the teeth its sides. This difference in length between the teeth and rakers should not exceed $^1/_{64}$-inch nor be less than $^1/_{100}$-inch, depending upon the nature of the wood to be cut, softer woods of course permitting the length of shorter rakers.

If no vise is available in filing, a stump may be sawed into from the top and the saw held in the cut, teeth upward. After all teeth on one side have been filed the saw is reversed and the remaining teeth are filed; this will be much more convenient than trying to file each tooth of both sides as the saw is passed through the cut. After the teeth have all been carefully "jointed," or filed to the same length, the rakers are next sharpened and filed down to the proper length, care being taken to see that they are all the same.

Setting.—This is necessary in order to allow for a kerf wide enough for the blade of the saw to pass through without binding, and is especially necessary when green or very soft timber is to be cut; a much narrower set is sufficient for hard timber through which the saw passes slowly.

The operation of setting a saw properly calls for considerable skill unless the woodsman has access to a regulation saw set made especially for the purpose; in such a case all that need be done is to regulate the set and then operate on each tooth.

But if no set is available the saw may be laid flat on a stump, and all the points along one side of the blade may be bent slightly outward by being tapped with some iron instrument. When the points along one side have been thus treated, the blade is turned over and the other teeth are given similar treatment. The chief disadvantage of this method of setting is the utter impossibility of directing the same amount of force against each tooth, thus leaving some with more set than others.

Rakers are never set.

Wedges.—These are used in hastening or directing the felling of timber, in relieving a saw of the pressure from the sides of

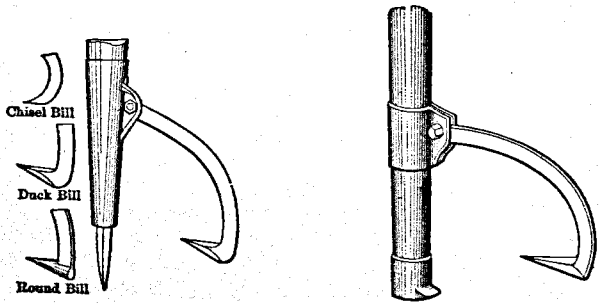
the kerf, in splitting or otherwise opening timbers, and forcing back the sides of the kerf when a saw is to be removed. There are of course numerous other uses to which wedges may be put, but these are the principal ones.

Wedges to be driven into kerfs where severe binding has occurred should not be struck a sharp blow at first; if this is done they are quite likely to rebound. Slight taps should be delivered

FIG. 164.—Wedges.

until they have been firmly set in the kerf, after which more vigorous blows may be struck.

If they prove to be too small or too thin for the splitting of heavy timbers, larger wooden wedges, known as "gluts," may



Socket peavy. Canthook.

FIG. 165.

be used to insert beside them. These, too, may rebound if struck too hard at first. They should be of very hard wood, and should have the large end rounded off to avoid splitting; ragged edges should be trimmed away.

ESTIMATING TIMBER

So many influencing factors enter into this line of work that a rather formidable problem is presented. The varieties and

sizes of timber, its condition and quality as affected by altitude and latitude and general climatic conditions, its accessibility by wagon or otherwise, its distance from market, the probable effect on other timber that its removal may have, and numerous other points involved, must all be given due consideration by the estimator and included in his reports. It is therefore obvious that to be a good estimator a field man must be a very close observer and must have good judgment and active perceptive powers.

Methods of estimating timber vary in different localities. Deductions for defects may be made from an ocular estimate; a certain number of average trees may be used as a basis for compiling an estimate on a given tract; or strips may be run through a country, estimates made to a certain distance either side of the center line, and the final report based on data thus secured. Local conditions are largely responsible for the different methods.

For example: Owing to the varieties of woods found on the same areas in the Arkansas forests, two men have worked together, one running the compass, pacing distances, and mapping the country, the other securing an estimate of the timber to a given distance either side of the line followed by the compass man. Ordinarily these lines were run through the center of each forty-acre tract and estimates were made to a point two rods away on either side. The area thus actually considered embraced two acres, or 5%, of the whole forty, and reports for the forty were based on the data so secured. Observations of poles, seedlings, and saplings were taken at given points along the line and covered given areas.

Reconnoissance men work alone, however, where timber occurs in solid stands, each man doing his own pacing, running his own lines, and making his own maps. Forty-acre tracts may be crossed twice if the density of the stand demands it.

A line through a forty is not run at random, as may be supposed, but is started and run from a regularly established point. Temporary base lines are established in unsurveyed country, and corners are set along these at intervals of 80 rods and at points which bring them at the middle of the forty lines. Such corners are only temporary in nature and are marked usually by stakes driven into the ground and scribed or numbered as desired. The base lines are started from some known corner

in a regular survey, as shown in Fig. 166, and are run in any direction the work may demand, usually however due north and south or east and west.

The cruiser starts at one of these temporary corners and paces

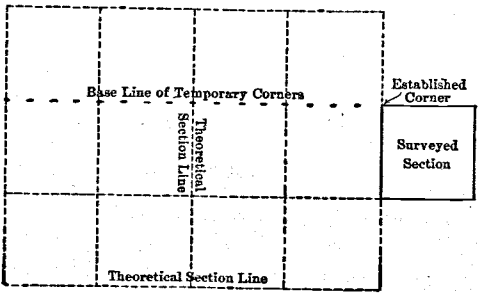


FIG. 166.

the distance from there to the center of the forty he is to "work." From there he runs through the middle of each succeeding forty as shown in Fig. 167, the arrows indicating his line of travel. He is expected to check his distances on section or quarter corners when he is working in surveyed territory, and thereby

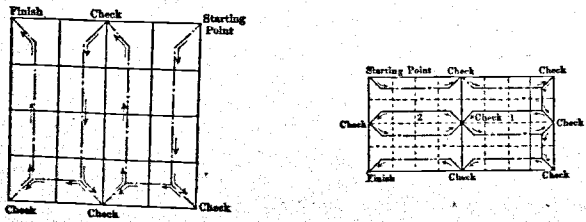


FIG. 167.

enable himself to rectify any errors in pacing that may have occurred. A little experience will soon make his work quite accurate and he will be able to check within a few rods of the corners.

In timber to be estimated, particular attention must be given

to all defects. These include, among others, spike tops, cat faces, frost cracks, crooked trunks, rotten limb stubs, holes, large or rotten knots, burned, rotten, or swelled butts, and other indications may appear which show a tree to be unsound.

There is no hard and fast rule that can be followed in determining just what constitutes a defect in standing timber, and the cruiser is therefore compelled to rely upon his own judgment and make his reports accordingly. His best and quickest method of securing a practical knowledge of defects is to follow defective logs through the mill and observe the internal condition of each one as it is opened up by the saw.

FELLING TIMBER

This begins after all preliminary estimates and other arrangements for a timber sale have been completed, and while it may not appear to be an important operation, it is, in fact, one which, unless it is carried on properly, may result in the sale being closed. It is imperative therefore that the field man in charge of the sale be familiar with what constitutes proper and improper felling.

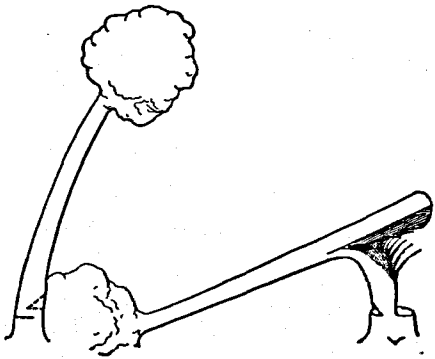
If a tree's exterior condition is such as to preclude all doubt of a worthless interior it should be left standing unless the contract specifically states that such material must be removed or at least felled. In most Government sales the contract embraces a clause providing for the removal or felling of any timber that may present a fire menace or which may result in damage to other timber if left standing.

One precaution which the field man should observe in his movements about the sale area where felling is in progress is to be on the lookout for large limbs left hanging in other trees and known as "fool killers." Such limbs may fall at any, time and it is never wise to work beneath them.

The first thing to be considered in felling is the direction in which the tree is to be thrown. If it is straight and the heavy top branches are evenly distributed around the stem, the ground is level, no strong wind is blowing, transportation facilities are equally good from any direction, other timber will not be damaged and other conditions permit, then it may as well be felled in one direction as another. If it leans as shown in Fig. 168, it should be felled if possible at right angles to the direction

of inclination. This eliminates to a degree the possibility of a broken or split stem as shown in the same figure.

If circumstances prevent it from being felled in such a manner



Method of notching and sawing leaning tree.

Stem split as result of improper notching.

FIG. 168.

it should be notched deeply on the side to which it leans. The saw should be started in on the opposite side at a point from 2 to 4 inches lower than the base of the notch; if started in above the notch the stem is much more apt to split. When splitting does occur, and the shattered butt is held high in the air, the workmen should retire in a line at right angles to the stem rather than backward from it. After precautions have been taken to see that the stem will not slip sidewise from the stump nor "kick" backward over it, the stump should be cut through from one side and the stem allowed to tip to that side. This operation is a dangerous one, as there is always a possibility of the crumpled branches in the top forcing the stem backward when the stump is cut through.

Double trees, growing together at a point sufficiently high to prevent them from splitting apart when felled, should be thrown as illustrated in Fig. 169. If it is apparent that they will split apart as soon as one is cut through, they may be felled away from each other.

A tree lodged in another as shown in Fig. 170 may be thrown

down by felling the supporting tree at right angles to it. A close watch should be maintained during this operation to see that pressure of the lodged tree does not cause the other to fall sooner or in another direction than that desired.

Felling timber across young growth and breaking it down should not be permitted, except, of course, where dense

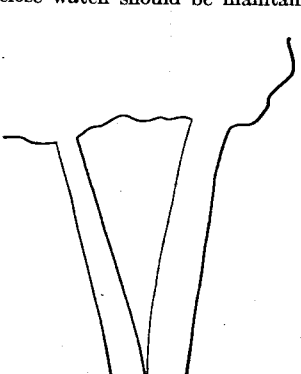


FIG. 169.—Notch for felling double trees.

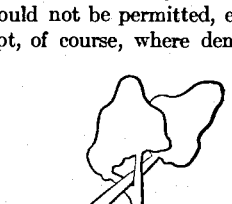


FIG. 170.—Lodged tree.

stands of young growth can not be avoided. Particular attention is given to this point in all Government sales, and when such felling occurs after one or two warnings from the officer in charge of the sale it may be considered sufficient cause for prohibiting further operations in the sale.

Refuse resulting from trimming and other operations must be piled compactly or else scattered, depending upon the terms of the contract. High stumps, as shown in Fig. 171, must also be avoided, the stump height usually being specified in the contract. Certain local conditions, such as short, scrubby timber with large, heavy tops or defective trunks resulting from burns, may justify a deviation from certain fixed rules, but this should never be done without the approval of the proper authorities.

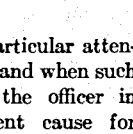


FIG. 171.

Another practice to be forbidden is felling trees across large logs, stumps, or rocks and shattering them until they are no longer merchantable.

Still another great loss may occur when trees are felled in such a position that the logs can not be hauled out without great expense. These points are all covered, however, in the contract,

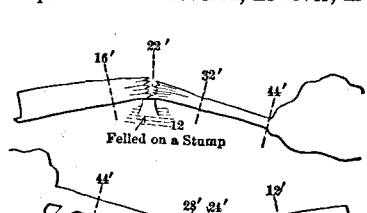


FIG. 172.

and they should receive the closest attention from the man in charge of the sale.

BUCKING LOGS

Improper bucking is responsible for one of the greatest losses in the lumbering industry. Crooked logs especially present excellent opportunities for careless buckers to waste an entire tree when one or more logs might, with proper bucking, be secured. If a tree is bucked at the 16-foot length as shown in Fig. 173, there is a 25% loss, all that portion of the log down

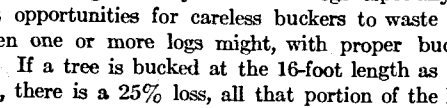


FIG. 173.

to the 12-foot length being total waste. If the same tree is bucked at the 12- and 20-foot lengths two good logs may be secured and practically all the tree utilized.

In Fig. 174, instead of cutting a butt log 16 or 18 feet long, losing the 2 or 4 feet in the crotch and going to the unnecessary trouble of cutting the two large limbs at 24 feet, and again at 36 feet, it would be much more profitable to cut a 12-foot butt

log, then cut the crotch at 24 feet and the branches at 36 feet, and thus secure four straight 12-foot logs. The ends of a few planks in the middle log might possibly be damaged, but the loss thus sustained would be much less than if the tree were bucked after the first method.

Fig. 175 represents loss in a top. The top log would provide enough sound lumber to make its removal from the woods profitable.

Another waste occurs where 2, 4, or 6 feet of sound log are left in a top merely because certain log lengths are desired.

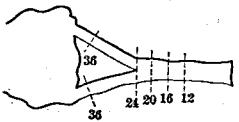


FIG. 174.

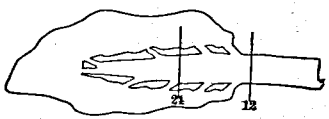


FIG. 175.

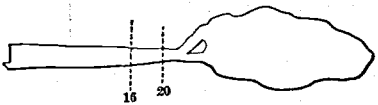


FIG. 176.

Thus, in Fig. 176, a 16-foot log is secured and a 4-foot length wasted. One 20-foot or two 10-foot logs would have resulted in practically no waste.

In Fig. 177 more than a foot of sound log is wasted. This is due to the fact that lumber is always cut in lengths of even

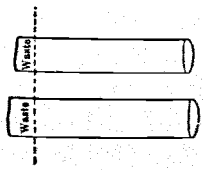


FIG. 177.

FIG. 178.

feet unless a special order calls for other lengths. Consequently the lumber in this log must all be cut back to 10 feet in length, while the log might have been cut 3 or 4 inches over 12 feet in length and made into 12-foot lumber.

The 11-foot log shown in Fig. 177 must also be made into 10-foot lumber. In Fig. 178 all of A is lost.

A trimming allowance of from 3 to 4 inches is usually allowed on all logs, although in Forest Service sales the allowance is usually specified as not more than 3 inches.

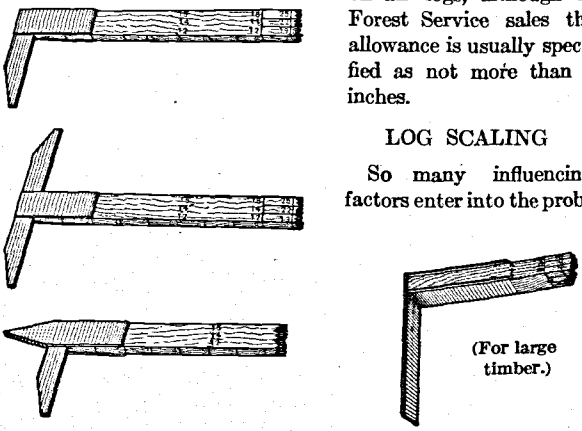


FIG. 179.—Log rules.

LOG SCALING

So many influencing factors enter into the problem of formulating a table by which the board feet contents of an unsawed log may be determined that there are a number of scales or rules used. Thus, the Scribner, among the oldest, may be used in one locality; the Doyle may be found in common use in another; the Doyle-Scribner is used in another; and the Champlain, International, Maine, or Cumberland River, or any one of thirty or forty others, may be used in other sections. Many small operators, particularly in the South, use no scale whatever, but measure each piece of lumber as it leaves the mill; others, operating solely for local trade, retain as their pay for sawing a certain per cent of the pieces sawed, this method being known as "sawing on shares." Official instructions issued to scalers are substantially as follow:

All scaling shall be done with the Scribner Decimal "C" rule.[1] Each log or piece, unless culled, shall be scaled, numbered, branded "U. S.," and recorded separately.

[1] For Log Rules, see p. 369, Appendix.

Standard ties (8 feet long, 6 inches thick, and 8 inches wide) may be sold either by the tie or by the thousand board feet, allowing thirty ties to the thousand feet. Ties of other dimensions may be sold likewise, except that a greater or smaller number, according to their size, must be allowed to the thousand feet.

Posts, poles, piles, stulls, etc., may be sold by the linear foot, by board measure, or by the piece, as stipulated in the contract. Each one shall be branded.

Wood sold by the cord should be branded both at the top and bottom of a pile, and a dozen or more other pieces in the pile also branded. "Merchantable" logs are those from which one-third or more of their contents as shown by the scale may be made into sound material. This term includes such material as will not grade lower than No. 3 Common as determined by the grading rules of the locality in which the timber is cut. Thus a log containing 240 board feet full measure is not "merchantable" if less than 80 feet can be made into "sound" material, but is merchantable if 80 feet or more can be utilized as "sound" material.

All logs exceeding 16 feet in length are to be scaled as two or more logs as nearly the same length as possible. This rule is departed from in Alaska and on the west slope of the Cascade Mountains in Oregon and Washington, where logs from 32 to 64 feet, inclusive, are to be scaled in a similar manner. Such scaling requires the operator to exercise his own judgment in allowing for increase in diameter of the lower logs. In doing this he can hardly follow any set rule although a

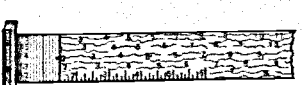


FIG. 180.—Board rule

table of such increase will be supplied for his general guidance.

Every fifth or sixth log shall be measured to ascertain whether or not the trimming allowance is being exceeded. In aggravated cases violation of this term of the contract shall be considered sufficient cause for cancelation of the contract. Other-